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Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

Evaluation of Monetary Policy in Ethiopia: An Empirical Study

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 15, 2015

Signature

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Abstract

In this paper, a structural vector auto regression (SVAR) approach is used to empirically investigate the effects of monetary policy shocks on output (measured by real GDP) and prices (measured by consumer price index) in Ethiopia. We isolated the SVAR structural shocks by imposing restrictions on the long-run behavior of the variables in the model, which places a recursive restriction on the disturbances of the SVAR. We considered three alternative policy instruments i.e. broad money supply (M2), lending rate and the real effective exchange rate (REER). We find evidence that price-based nominal anchors (Interest rate and REER) have an effect on real output, a modest effect of the lending rate while a significant effect of REER is documented, with a slightly faster speed of adjustment. Similarly, innovation in the quantity based nominal anchor (M2) affects economic activities significantly.

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Keywords	Monetary Policy Evaluation, SVAR, Output Effect, Price Effect

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Contents

List of Tables ..... **vii**

List of Figures ..... **viii**

Acronyms ..... **ix**

Master's Thesis Proposal ..... **x**

1 Introduction **1**

2 Literature Survey **3**

2.1 Theoretical Literatures **3**

2.2 Empirical Literatures **7**

2.2.1. Monetary policy and Inflation 8

2.2.2. The effect of anticipated vs. unanticipated shock in Monetary Policy . 9

2.2.3. Monetary policy transmission mechanism 10

2.2.4. How fast does monetary policy matter 11

2.2.5. Monetary policy rules versus discretion 12

2.2.6. The Effect of Monetary policy and level of economic development .. 13

3 An overview of monetary policy Framework in Ethiopia **17**

3.1 Monetary Policy Instruments in Ethiopia **18**

3.1.1 Reserve Requirement 19

3.1.2 Open Market Operations 20

4 Baseline model **23**

5 Empirical Methodology **27**

5.1 The Benchmark SVAR Specification **27**

5.1.1 Identifying restriction 29

5.2 Data Overview 31

5.3 Preliminary Statistical test 36

5.3.1 Test for unit root 36

5.3.2 Structural Break 37

5.3.3 Seasonality 38

6 Estimation Result and Discussion 40

6.1 Lag Order Selection 40

6.2 Serial correlation / Misspecification Test 43

6.3 Model Stability 43

6.4 Estimated Response of Output and Price to Monetary innovation 45

7 Conclusion 50

Bibliography 52

Appendix A: Time Series 57

List of Tables

Table 5.1: Summary of descriptive statistics 34
Table 5.2: summary result of stationary test 36
Table 5.3: Test for Structural Break using Zivot-Andrew 38
Table 6.1: VAR Lag Order Selection Criteria 40
Table 6.2: Vector Auto regression Estimates 41
Table 6.3: VAR Residual Serial Correlation LM Tests 43
Table 6.4: Variance Decomposition of D(LY) 50
Table 6.5: Variance Decomposition of D (LCPI) 50
Table 0.1: Unit root test result 59
Table 0.2: Zivot-Andrews test for unit root with structural break 60

List of Figures

Figure 5.1: logarithm of Quarterly Gross Domestic Product 31

Figure 5.2: Logarithm of Consumer Price Index (CPI) 32

Figure 5.3: Development of variables over time in percentage change 33

Figure 5.4: Logarithm of Output gap estimate using H-P Filter (Lambda = 1600) 35

Figure 5.5: Percentage change of consumer price index by season 39

Figure 5.6: Gross Domestic Product (GDP) by season 39

Figure 6.1: VAR model stability test using Inverse Roots of AR Characteristics Polynomial 44

Figure 6.2: Response of Output and Price to Monetary Policy Innovations 46

Figure 0.1: Time Series plots 57

Figure 0.2: Output (measured by output gap) and Price effect of innovation in monetary policy 61

Figure 0.3: Output gap estimate using H-P Filter (Lambda = 1600) 62

Acronyms

ADF Augmented Dickey Fuller

AIC Akaike Information Criteria

CPI Consumer Price Index

DF Dickey Fuller

FPE Final Prediction Error

GDP Gross Domestic Product

HQ Hannan-Quinn information criterion

IMF International Monetary Fund

RGDP Real Gross Domestic Product

SIC Schwarz Information Criteria

VAR Vector Auto Regression

Master's Thesis Proposal

Author:	Bc. Alemayehu Demissew Taye
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Proposed Topic:

Evaluation of Monetary Policy in Ethiopia: An Empirical Analysis

Topic Characteristics:

Since the earliest time of classical monetary theorist, many economic researchers, academicians' and policy makers have been interested to empirically investigate the queries regarding the effectiveness of monetary policy in affecting real variables of a given economy. In spite of consensus in literatures about the temporary impact of monetary policy in affecting real macroeconomic variables, the issue regarding the size and speed by which an economy adjusts to monetary policy reactions are still a debatable topic in economics. These mixed results could have been mainly due to the fact that the empirical investigation is highly dependent on the structure of the economy to be studied, the empirical methodology being employed, sample selection and choice of economic variables and the identifying restrictions imposed on the models.

Many empirical literatures are predominantly done for the developed economy, but very limited studies on developing economies. As can be seen from studies by; Alessio Anzuini et al. 2012, Fabio C. Bagliano, 1998; John H. Cochrane, 1998 and Stephen G. Cecchetti 2006. Even though these studies brought puzzling results from their analysis, however, there seems to be a consensus about the impacts of monetary policy shocks on output and prices in the developed economies as Fabio C. Bagliano, Carlo A. Favero, 1998 discussed for the USA.

Proper measurement and understanding of the effectiveness of monetary policy and the role it plays has paramount of importance for pro-active and forward looking policy making, which should be based on scientific macroeconomic framework. It could be worth nothing to mention there would have been some effort to empirically study this topic for the case of Ethiopia, since it is hardly possible to find them published on noted economic journals. As a result, it would be pretty curious case to investigate this topic in the case of Ethiopia using SVAR, where the economic structure is quite different from the mainstream one, in which the monetary policy believed to function very well.

Hypotheses:

1. Hypothesis #1: Does monetary policy affect the general price level and the output of the economy (real vs. nominal effect)?
2. Hypothesis #2: How effective is the monetary policy in this country (how fast the economy adjusts in response to some shocks)?
3. Hypothesis #3: which policy instruments are suitable for the existing economic situation, which could result in price stability?

Methodology:

We will specify a theoretical model with its underlying assumption, on which my empirical analysis will be based on. To investigate the effectiveness of monetary policy in Ethiopia we will use econometric analysis using secondary data sourced from National Bank of Ethiopian and International database sources. Because they are supported and tested in many empirical works; BVAR or Structural Vector Auto regression (SVAR) with identifying restriction will be implemented during the econometric analysis process. The variables included will be the interest rate, real gross domestic product (RGDP), exchange rate (REER), money supply (M2) and consumer price index (CPI) some others will also be included in case it is important. All data will be quarterly data, since there is no quarterly data on GDP for Ethiopia interpolation will be used to obtain quarterly GDP.

Outline:

1. Introduction
2. Literature Survey
3. An Overview of Monetary Policy in Ethiopia
4. Baseline Model
5. Data and Empirical Methodology
6. Empirical result and discussion
7. Conclusion

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Author **Supervisor**

1 Introduction

Since the earliest time of classical monetary theorist, many economic researchers, academicians' and policy makers have been interested to empirically investigate the queries regarding the effectiveness of monetary policy in affecting real variables of a given economy. In spite of there has been a consensus in literatures about the temporary impact of monetary policy in affecting real macroeconomic variables, the issue regarding the size and speed by which an economy adjust to monetary policy shocks are still debatable topic in economics. These mixed results could have been mainly due to the fact that the empirical investigation is highly dependent on the structure of the economy to be studied, the empirical methodology being employed, sample selection and choice of economic variables and the identifying restrictions imposed on the models. Many empirical literatures are predominantly done on developed economy but very limited studies on developing economies. As can be seen from studies by (Anzuini, Lombardi, & Pagano, 2012), (Fabio C. Bagliano, 1998), (Cochrane, 1998) and (Cecchetti, Flores-Lagunes, & Krause, 2006). Even though these studies brought puzzling results from their analysis, there however seems to be a consensus about the impacts of monetary policy shocks on output and prices in the developed economies as (Fabio C. Bagliano, 1998) discuss for the USA.

Proper measurement and understanding of the effectiveness of monetary policy and the role it plays has paramount of importance for pro-active and forward looking policy making, which should be based on scientific macroeconomic framework. It could be worth nothing to mention there would have been some effort to empirically study this topic for the case of Ethiopia, since it is hardly possible to find them published on noted economic journals. As a result, it would be pretty curious case to investigate this topic in the case of Ethiopia using SVAR, where the economic structure is quite different from the mainstream one, in which the monetary policy believed to functions very well. Therefore, the objective of this research paper is primarily to empirically investigate effectiveness of monetary policy in Ethiopia. In spite of a wide interest in the effectiveness of monetary policy most of the empirical studies were done during the last decades, On the other hand, the empirical researches on this topic in developing world have been extremely limited. This study will

present the opening discussion in this topic for the region and could be used as a reference for further investigation and discussion on the topic. Analyzing monetary policy has gained special importance, as the economy is experiencing expanding output bottlenecked by higher inflation rate. So that, presumably this study will also contribute at least some input for policy makers and researchers.

The thesis is structured as follows: Section two provides a detailed and critical review of theoretical and empirical scientific literatures, published on accredited journals. Section three provides a detailed critical review of monetary policy practice and trends in Ethiopia. Section four present the theoretical model that underpin empirical investigation of the thesis. Under section five a brief explanation, regarding sampling, data type, and data collection are presented along with a detailed description of econometric framework, employed for the analysis of the thesis in particular structural vector autoregressive model (SVAR). Results from econometric estimation, model diagnosis and discussion of result are fully detailed in section six. Finally, the thesis concludes with summarizing core findings of the research with a policy implication and possible recommendation.

2 Literature Survey

In this chapter a detailed literature survey is presented. Section 2.1 fully devoted for a brief discussion of basics about monetary policy; history and recent development as discussed in theoretical literatures. Moreover, in section 2.2 a detailed and critical review of empirical literature is discussed on the topic, an evaluation of monetary policy, with major emphasis put on their core finding and comparison of methodologies adapted in different scientific literatures.

2.1 Theoretical Literatures

There is no doubt that the ultimate objectives of economic policy in any economies in the Globe are to ascertain long-lasting economic progression and development. As a strategy to attain those economic goals, different economic policy measures has to be formulated and put into action. Among such policies, money policy has got a central role at achieving the desired economic outcomes such as; moderate inflation rate, low unemployment rate, foreign trade balance, and exchange rate and interest rate stability. More generally, it used to attain stable and well-functioning macroeconomic environment in an economy.

Monetary policy involves a number of rules, traditions and practices which may be jointly called operating procedures. These procedures are composed of instruments, operating targets, intermediate targets and policy goals. The instruments of economic policy are those variables that are directly controlled by the Central Bank of the nations. In many countries a number of monetary policy instruments have been used. These include moral suasion, changes in the discount rate, commercial bank reserve requirements, the intervention in the setting of deposit and loan rates, credit limits, intervention at treasury bill auction, pricing of government securities to market and purchase, sale and repurchase of treasury bill and other government securities (Boamah & Moore, 2014).

These instruments are then influenced to achieve some pre-specified operating target such as commercial bank reserve or rate of interest. Intermediate targets are those variables that fall between operating targets and policy goals. They are usually used to glean some idea of how effective the policy has been in achieving the policy

goal in the medium term due to the infrequency of observation on the variable of interest. Policy goals are those variables of critical interest to policy makers. The use of these operating procedures varies according to the policy regime the country adapts. (Boamah & Moore, 2014)There are four basic types of monetary policy regimes that are in use around the world. These include exchange rate, monetary and inflation targeting regimes, along with monetary policy with an implicit, but not an explicit nominal anchor (Mishkin F. S., 2002).

Despite, there is a wide agreement that monetary policy is a tool in promoting economic growth and stabilizing inflation. However, there is less agreement about how monetary policy exactly exerts its influence. Most of the empirical researches frequently regard monetary transmission mechanisms as a "black box." In order to make accurate assessment of the magnitude, timing and duration of monetary policy, the policymakers need to understand the mechanisms through which monetary policy affects the economy. (Mishkin F. , 1999) Highlighted that the monetary transmission mechanisms including the interest rate channel, the exchange rate channel, the asset price channel and the credit channel.

The interest rate channel is the primary monetary transmission mechanism in the conventional macroeconomic models, such as IS-LM model. Those models hold that monetary policy operates through the liability side of banks' balance sheets: given some degree of price stickiness, a change in money is transmitted to the real economy through its impact on the cost of capital and consumption.[1] In contrast, bank loans, which are one of the bank assets are regarded as instruments in the bond market,[2] and then Walras' Law can conveniently suppress it.[3]

However, as pointed out by (Bernanke & Gertler, 1995), the empirical studies have had great difficulty in identifying quantitatively important effects of interest rate through the cost of capital. They state that the macroeconomic response to policy-induced interest rate changes is considerably larger than that implied by conventional estimates of the interest elasticity of consumption and investment. This observation

[1] Some economists, such as John Taylor, claim that there is strong empirical evidence for interest-rate effects on consumer and investment spending through the cost of capital, hence making a strong interests rate channel of monetary transmission

[2] According to the Modigliani-Miller (1958) theorem, with complete information, there is perfect substitutability between bonds and bank loans.

[3] Walras' Law states that, in general equilibrium theory, if N-1 markets are in equilibrium, the N-th market must also be in equilibrium

suggests that mechanisms other than the interest rate channel may also work in the transmission of monetary policy.

Since some scholars are dissatisfied with the orthodox money view, a new view of the so-called credit channel springs up. This view emphasizes the importance of the credit markets.[4] The credit channel is not a distinct alternative to the traditional interest rate channel, but rather as a set of factors that amplify and propagate interest rate effects. In general, the credit channel of monetary policy transmission can be subdivided into two channels: the balance-sheet channel and the bank-lending channel.

The balance-sheet channel developed by Bernanke and Gertler (1989) operates through the net worth of business firms. Contractionary monetary policy causes a decline in equity price or a reduction in cash flow. Therefore, it lowers net worth of business firms because of the increase of the adverse selection andmoral hazard problems,[5] in turn leading to decrease lending to financing investment and consumption (Bernanke & Mishkin, 1997).

The bank-lending channel is based on the view that banks play an important role in the financial system because they specialize in alleviating asymmetric information problem and other frictions in credit market.[6] For certain types of borrowers, especially small firms, the bank credit is the only source to obtain fund.[7] If the supply of bank loans is disrupted, those bank-dependent borrowers may incur costs associated with finding a new lender, even being shut off from credit. Therefore, contractionary monetary policy that reduces bank reserves and deposits will decrease the availability of bank loans. Because small firms and households rely heavily on the bank financing, a reduction in loans will lower investment and consumption and then depress aggregate spending.

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[4] Therefore, the asymmetric information and the enforcement of contracts in the credit market may play the roles in the transmission process of monetary policy.

[5] Lower net worth means that the lenders in effect have less collateral for their loans, and hence losses from adverse selection are higher. Meanwhile, lower net worth also increases the moral hazard problem because it means that owners have a lower equity stake in their firms, giving them more incentive to engage in risky investment projects.

[6] This idea goes back at least to Roosa (1951) and was restarted in an influential paper by Bernanke and Blinder (1988).

[7] For the large firms, they can directly access the credit markets through stock and bond markets without going through banks.

(Bernanke & Blinder, 1988) First establish a theoretical macroeconomic model with the bank-lending channel. They extend the standard IS/LM model by explicitly modeling the credit market independently from the money market under the assumption of imperfect substitutability among all bank assets. By allowing for the coexistence of the auction-market credit (bond) and the customer-market credit (bank loans), they show that an increase in money supply influences the output not only through the interest rate channel, but also through the credit channel. Furthermore, expansionary monetary policy has a more potent effect on output under their model than under the standard IS/LM model.

2.2 Empirical Literatures

The recent advancement in the evolution of Dynamic Stochastic General Equilibrium (DSGE) and Vector Autoregressive model, and widespread application in medium-scale structural framework with having fulfillment in data consistency and better forecasting performance have significantly widened the room for empirical analysis and better equipping researches towards monetary policy evaluation in recent periods.

Accordingly, (Adjemian, Paries, & Moyen, 2008) has made a study called, "towards a monetary policy evaluation framework." They estimated pure DSGE model with only a slight modification on the specification of (Smets & Wouters, 2007), underpinned by a monetary policy set according to Ramsey Social planner decision problem. Moreover for sake of contrasting, they estimated a DSGE model with a VAR extension on the same monetary policy according to Ramsey planner decision problem setting with Taylor type interest rate rule. What they found was, the restriction imposed by the welfare-maximizing Ramsey policy degenerating the empirical quality in comparison to a Taylor rule specification. On the other hand they found both model provide the same result for productivity shocks. Their conclusion that Taylor rule specification of monetary policy best describe the US data, is not a surprising result since it is abundant in many scientific literatures, though many of them are in VAR framework.

Having introduced to our analysis of empirical literature survey with the above paragraphs. For the sake of detailed and critical analysis we have chosen to address the literature survey subdivided into section, according to their main area of focus.

2.2.1. Monetary policy and Inflation

Theory of inflation and monetary policy are highly interrelated concept in macroeconomics. Inflation is defined as an increase in the average price of goods and services in terms of money, (Romer D. , 2006). There has been an ongoing debate among scholars about what cause a higher inflation in certain economy. Monetarist's school of thought argues that if the Money Supply increases faster than the output growth rate then there will be inflation. Which was well articulated in the famous Milton Friedman's quote, "inflation is always and everywhere a monetary phenomenon."

The second approach into the analysis of determinate of inflation by Keynesian economic theory, says change in money supply does not affect real variable of an economy. According to Keynes school classification, there are three factors causing inflation such as; demand-pull inflation: caused when total spending of an economy is high causing higher aggregate demand and hence increase the inflation because of increased aggregate demand, cost-push inflation also referred as "supply shock inflation:" this is an opposite analogous to demand pull-inflation, happened when aggregate supply is fall short of aggregate demand and built-in inflation: happens when workers tended to maintain higher wage, hence employers increases the price of their product to offset the rise in cost of production.

(Anzuini, Lombardi, & Pagano, 2012), Has empirically studied the relationship between monetary policy and commodity price at a disaggregated level for the US economy, using VAR methodology with varied identifications. Then, found that, a rise in money supply significantly increases the aggregate commodity price along with all of its components, even though, not with overwhelmingly large magnitude. Then empirically confirmed inflation in the US economy is largely derived by monetary phenomena, supporting the monetarist point of view.

Similarly, (Baydur & Süslü, 2004) has conducted a research on the relationship between inflation and monetary policy on the Turkish economy based on Sargent and Wallace's approach; in which the baseline assumption is that, "tight monetary policy is more inflationary than the loose one." Then, their empirical finding evidenced that the tight monetary policy implemented by Turkish central Bank from 1987-97 has rose inflation, on contrary loose monetary policy in 1997 has declined inflation rate in the Turkey. Despite difference in the methodological approach and distinct economic structure In the US and the Turkey economy, the

results form (Anzuini, Lombardi, & Pagano, 2012) and (Baydur & Süslü, 2004) are essentially suggesting similar results however.

2.2.2. The effect of anticipated vs. unanticipated shock in Monetary Policy

The issue of anticipated versus anticipated monetary policy shock in affecting real variable has been one of the persisting debate in the arena of macroeconomics. Since 1970s, a numerous literature has been read on the issue, which emphasize a substantial attention attached to it. A substantial progress in both theoretical and empirical literature has therefore allowed much deeper insight into the topic of real effect of anticipated versus unanticipated sock in monetary policy. In the following paragraphs we will discuss results and methodology from available empirical works on the topic.

In the 1970s, the new classical economist has come up with a new approach to macroeconomics, the distinction between anticipated and unanticipated shock to nominal variables such as, shocks in money growth, to affect real variables. Concurrent economists of 70s such as (Robert E. Lucas, 1972), (Phelps, 1967) and (Friedman, 1968) in their seminar work have found that only unexpected shock to money supply (money surprise), which can affect real variables like output and employment. On the other hand, some economists like (Taylor, 1979) and (Romer & Romer, 1994), particularly those of also known as the synthesizers of Keynesiantraditions have brought a contrasting result to those of new classical economists that anticipated shock to money supply does also have a real effect.

Furthermore, (Cochrane, 1998) has conducted a study in which he had introduced an interesting approach to conventional VAR methodology that most literature focused on. In doing so, under identifying restrictions he had specified the real effect of anticipated and unanticipated change in money supply. Using VAR, then computed the effect of change in money on output as one varies the assumption of anticipated versus anticipated change. Then concluded, the change in assumption of anticipated versus unanticipated shock to money supply, affects more than variable selection and identifying specification.

Similarly, (Gottschalk & Hoppner, 2001) has investigated the topic for the Euro area using structural VAR methodology. Their result that, anticipated monetary policy had considerably affect output for the last two decades, is not surprising result

in the face that their model had been built according to (Cochrane, 1998) prescription. What is rather interesting finding form their research, was regarding real effect of systematic response of monetary policy in response to aggregate demand and supply shocks. That is, counter-cyclical path of monetary policy in a response to aggregate demand shock and pro-cyclical in response to aggregate supply socks.

2.2.3. Monetary policy transmission mechanism

As detailed in the above section, Mishkin (1995) usefully describes the various channels through which monetary policy actions, as summarized by changes in either the nominal money stock or the short-term nominal interest rate, impact real variables such as aggregate output and employment. Thus many studies have been conducted to investigate monetary transmission for various countries. In the following paragraphs we will review a selected relevant empirical findings.

A large number of empirical studies have investigated the channels by which the supplement lending effects are transmitted. (Bernanke & Blinder, 1988), Use innovations to Federal funds rate as a measure of changes in policy[8], they find that monetary policy impulses affect the composition of bank assets systematically. They show that contractionary monetary policy leads to a short-run sell-off of banks' security holdings, while it has little effect on loans. However, shortly thereafter, the securities start rebalancing, but loans begin to decline. Hence, tighter monetary policy can depress the economy by means of the reduction of loans supply. It implies that monetary policy works at least in part through "credit" (i.e., bank loans) as well as through "money" (i.e., bank deposits).

All of the above literatures concentrate on the analysis of credit channel under a closed economy. As financial markets become more internationalized, the conduct of monetary policy turns more complicated in the open economy. Therefore, the recent studies extend the discussion of credit channel into the case of an open economy. (Chiades & Gambacorta, 2004), Analyze the monetary policy transmission mechanisms and find the conditions under which monetary policy can be aimed at policy targets despite international capital mobility and adherence to fixed exchange rates. However, the viewpoints obtained in their studies are doubtful. As a matter of the fact, under the regime of fixed exchange rate, the money supply becomes

[8] (Bernanke & Blinder, 1988) Show that Federal funds rate is a good indicator of monetary policy actions because the funds rate sensitively records shocks to the supply of bank reserves.

endogenous such that monetary policy is still ineffective in influencing output even with an operative credit channel. It is hard to convince people that the credit channel operates and monetary policy can have real effects under the regime of fixed exchange rates.[9]

However, under the regime of floating exchange rate, there is a room for the credit channel to operate. If the domestic currency depreciates, the credit channel would amplify the expansionary effect of monetary policy on output. (Romirez, 2004), Extends Bernanke and Blinder's model to the open economy under floating exchange rates and claims that monetary policy is much more potent with credit channel. (Isakova, 2008), Further investigates the model with imperfect international capital mobility and finds that, under the case with relative high capital mobility, expansionary monetary policy may lead to a fall in the exchange rate via a credit channel and an appreciation in the currency in turn offsets part of expansionary monetary effect. Yet, Tsai's model ignores the effects of international credit flows.

Few literatures have studied the monetary transmission mechanism of credit channel under the floating rates and investigated the corresponding dynamic adjustment process after a monetary expansion. Therefore, this paper attempts to fill in this gap. Furthermore, the international credit flows would be explicitly specified in the capital account with imperfect international capital mobility. Finally, the volatilities of macroeconomic variables will be examined by checking the dynamic adjustment process of the output and the exchange rate.

2.2.4. How fast does monetary policy matter

In the above paragraphs, so far we have discussed an important concerns in macroeconomics literatures, which are highly motivated by the inquiry of whether, to what extent, and why monetary policy matters. Regarding the two questions, substantial empirical literatures has led to a harmonized agreement, that a shock to money supply has a real effect on macro-variables specifically output in advanced industrial and in the most of transition economies. But the issue of "how fast monetary policy matter?" is under ongoing debate in recent literatures.

[9] Besides, (Chiades & Gambacorta, 2004) assume the price flexibility and the money neutrality ($p=w=m$) in their model. However, these assumptions are contradictory to the results that monetary policy is effective.

Despite what has been written in the article by (Olivei & Tenreyro, 2007), that a vast majority of literature has found a delayed and persistent effect of money shock on GDP. (Shingo, 2013) Has investigated, whether monetary policy in 1980s was delayed in the Japanese economy. Indicated in his paper that the conclusion of (Jinushi, Kuroki, & Miyao, 2000) was not able to present sufficient evidence, which could show the effect of monetary policy during 80s was really delayed, since they did not address the latent interest rate gap. (Shingo, 2013) Considered the case again using a dynamic stochastic general equilibrium (DSGE) model, explaining structure of the economy, then employed a Bayesian techniques also referred as the Bayesian-DSGE (B-DSGE) model. And concluded that the effect of monetary policy was not delayed, rather the authority could not got to know the condition of the economic situation, that is monetary policy was unexpectedly tight since the year 1985.

2.2.5. Monetary policy rules versus discretion

It can be (Boamah & Moore, 2014) witnessed that there is high resurgence of motivation in the recent literatures regarding the issue of how monetary policy should be conducted. This could be noticed from fact the over the past few years most advanced economies have either certain proposed monetary policy rules or set on certain course of situation monetary policy should take in discretion. John Taylor's prescription of a simple interest rate rule well know a "Taylor rule" and the recent widespread endorsement of inflation targeting for the most part could be a good evidence see (Bernanke & Mishkin, 1997).

Similarly, (Clarida, Gali, & Gertler, 1999), in their article in which they investigated the monetary policy design delinquency using a simple baseline theoretical model. Two factors are mentioned that considered would causing the rebirth of interest in this topic. On one hand, after quite a long period of focus on the role of other factors than monetary factors in the business cycle, a number of empirical study that begun to materialize in the late 1980s has brought evidences that monetary policy matters in the short run. On the other hand, there has been a remarkable advancement in the underlying theoretical frameworks employed for the monetary policy analysis. In order to make a theoretical foundations, the literature has incorporated the methods of dynamic general equilibrium theory initiated in the analysis of real business cycle, which introduced the incorporation of frictions such as imperfect information, needed to be modeled for the better evaluation of monetary policy.

Viewed in more detail, the importance of shifting paradigm from conventional discretionary based monetary policy to establishment that allow a serious commitment to general price and exchange rate stability, such as inflation targeting, monetary unions and adoption of currency board have been discussed widely in recent literatures. Specifically (Clarida, Gali, & Gertler, 1999) considered the implication of macroeconomic frictions, imperfect information in particular and finally underlined the benefit of using a credible commitment to combat higher inflation.

However, the use of monetary policy rule gaining popularity, there also seems consensus in literatures that discretionary policy allow Central Banks to use certain monetary policy instrument in order to absorb adverse shocks when there will be discrepancy between actual and potential output. The other version of monetary policy rule prescription, is the one discussed in the article of (Mishkin F. S., 2002), which provides the use of countercyclical monetary policy with flexible inflation targeting, because rigid monetary policy rules could would inhibit the ability of the Central Bankers the adjust with output instability with respect to natural level of output

2.2.6. The Effect of Monetary policy and level of economic development

2.2.6.1. Developed Economy

Literatures have brought substantial evidence that the monetary policy is effective in affecting real macroeconomic variables, in industrialized economies, such as US and advanced European countries see (Leeper, Christopher, & Tao, 1996), (Orphanides, 2003), (Cochrane, 1998), (Bernanke & Mihov, 1998), (Fabio C. Bagliano, 1998) and (Anzuini, Lombardi, & Pagano, 2012). (Fabio C. Bagliano, 1998) Studied the monetary transmission mechanism for the US using VAR model considering, specification, identification and effect of omitting the long-term interest rate and find that long-term interest rate is a crucial determinant of the reaction function of the monetary authority.

In the same fashion, (Bernanke & Mihov, 1998) developed a VAR model in order to measure shock in monetary policy and its real effect and compared different approach to capturing innovation to monetary policy and brought a new approach of

measurement, which takes the central bank's operation procedure into account. Likewise. (Leeper, Christopher, & Tao, 1996), Employed a vector autoregressive model and considered a traditional trend in monetary economics, that seeking for a single monetary policy instrument. Discussion form this articles brought an important contribution to empirical literatures that a conventional approach of manipulating stock of money supply as monetary policy tool to stabilize macroeconomic evils, is less relevant than using interest rate. Mainly due to the fact that the growth rate of monetary aggregates is determined by various non-policy related factors.

As discussed above in the (2.2.2), (Cochrane, 1998) considered and the issue of effectiveness of anticipated and unanticipated monetary policy on real variables, however what could be drawn from his paper was also in line with majority of literatures on the US economy. That monetary policy is effective enough to be used, whether to stimulate or dampen economy. Likewise, according to a recent study by staffs of Federal Reserve Bank of San Francisco (John, Mark M, & Swanson, 2014), china has been reported to having a monetary policy transmission channels, which is moving closer to those of Western market economies.

Moreover, (Starr, 2005) in his paper focused on the sticky and flexible aspect of price in the essence of new Keynesianism. Then stressed the importance of considering various determinants of effectiveness of monetary policy. (Orphanides, 2003), In his study on the US economy, investigated the implication of considering noisy information in measurement of economic activity for the evaluation of the effectiveness of monetary policy. Hence, showed leaving out to consider noise in the historical data can seriously distort the real situation of plausible macroeconomic outcomes and result in inefficient policy guideline.

No matter the approach that different authors have adopted, there is sufficient evidence in many scientific literatures regarding various determinants of the effectiveness of monetary policy. That is, the effectiveness of monetary policy shocks is a function of set of several variables. Therefore, a Simple and mere adoption of policies identified as efficient when these real life economic difficulties are overlooked it can results in worse macroeconomic performance than it is in actual experience.

2.2.6.2. Transition Economies

As discussed in the above subsection, in most advanced industrial economies, the changes in monetary policy affect real macroeconomic variable in the short run and growth in the general price level (Inflation) in the long run. However this question for the transition economies is under an ongoing debate. Recently, a number of empirical literatures shows, shocks to monetary policy have a moderate effect on output and employment in transition economies in comparison to the most advanced industrial economies, for detailed analysis, see (Isakova, 2008), (Ganev, Gregory, Krisztina, & Krzysztof, 2002) and (Starr, 2005)

(Ganev, Gregory, Krisztina, & Krzysztof, 2002), Conducted a study on the effects of monetary policy in ten Central and Eastern European countries (CEE) including the Czech Republic and found no indication that interest rates can affect GDP, but exchange rate did in most countries. But the response of inflation is in line with the theoretical expectation that is inflation is damped by higher interest rate and exacerbated by currency depreciation. Similarly, (Starr, 2005) using time series data with a structural vector autoregressive model, examined the real effects of shocks to monetary policy in five Commonwealth of Independent States (CIS), such as Russia, Ukraine, Belarus, and Kazakhstan. And have discovered a mixed evidence that monetary shock affect real variables, with exception in Russia that output significantly impacted by interest rate change.

Furthermore, we can observe that there are mixed results in empirical literatures. Monetary policy focused on the use of monetary aggregate has happened to be less efficient in some transition economies. The possible cause of these inefficiencies have been discussed in various literatures, such as (Isakova, 2008) studied the case for the Central Asian countries. Thus, sticking to the use of monetary aggregate as the only optimal monetary policy tool is losing its popularity in the transition economies. Because, there are various factor, which could obstruct the monetary transmission mechanism such as intense dollarization, under developed financial and capital markets, poor monetized economy, for detailed discussion see (Isakova, 2008).

2.2.6.3. Developing Economies

In contrary, the evidence is weak and full of contradiction for emerging economies in general. For instance, (Balogun, 2007) and (Chuku, 2009) had conducted a study to investigate the effectiveness of monetary policy in Nigeria and come up with conflicting result though.

Viewed in more detail, (Balogun, 2007) adopted a simultaneous equation model, and found monetary policy was the source of economic stagnation and higher commodity price in Nigeria rather than promote growth. Whereas, (Chuku, 2009) used a structural vector auto regression (SVAR) model to find the effect of growth in money supply on output and inflation level in the Nigerian economy. He had conducted a controlled experiment using three alternative monetary policy tools, such as broad money supply, real effective exchange rate and minimum rediscount rate. Finally, came up with a conclusion, that the manipulation of broad money supply (M2) by the Central Bank is the most influential monetary policy instrument in achieving the desired economic outcomes than price based nominal anchor, minimum rediscount rate (MRR) and real effective exchange rate (REER).

The appropriate identification of the effect of monetary policy shock is a crucial thing for a good policy making that will eventually leads to the desired economic stability and growth. Despite it did take many factors into account and had employed good model suggested in recent empirical literatures, the firm policy recommendation of (Chuku, 2009) would lacks reliability, since it was merely based on the underlying assumption that “the Central Bank cannot observe unexpected changes in output and prices” within the same period, which used to made a recursive restriction on the innovation of the SVAR model.

3 An overview of monetary policy Framework in Ethiopia

The practice of monetary policy in Ethiopia was believed to set in 1963, during the monarchial regime, when the National Bank of Ethiopia (NBE) established by proclamation 206 of 1963 by which the bank formally entitled administrative autonomy and juridical personality. Following the overthrow of the Imperial regime, the country fall under the rule of communist regime (1974-1991). Then, the monetary variables were under the strict command of the central bank, where interest rate were fixed so as to restrict the private sector participation in the economy. The supply and demand interplay of the financial sector were not only extremely inhibited by the credit ceiling placed on commercial banks but also by the rule which had forced the banks to lend prioritized sectors. The banks operating in the economy were limited to three; Commercial Bank of Ethiopia (CBE), Development Bank of Ethiopia (DBE) and Construction and Business Bank of Ethiopia (CBB)

Following the 1991 change of government, the country has experienced radical shift in the sphere of political economy. Monetary and Banking Proclamation of 1994 established the Monetary Authority as a judicial entity, separated from the governments and allowed private banks and insurance companies to operate in the industry. Monetary and Banking proclamation No 83/1994 and the Licensing and Supervision of Banking Business No. 84/1994 laid down the legal basis for investment in the banking sector.

Currently, the Central Bank is working towards achieving three fundamental objectives such as; to maintaining price and exchange rate stability, to foster a sound financial system and to undertake such other function as are conducive to the economic growth of Ethiopia. In the course of attaining these objectives the National Bank has identified the conditions it claimed are peculiar to Ethiopia economy such as the importance of foreign sector and the instructional set up of the country. Then the monetary policy framework of the country involves the following three targets;

Ultimate Target: is to maintain price and exchange rate stability, and support economic growth of the country.

Intermediate Target: are used in order to achieve the ultimate objectives of the Bank, and growth in the broad money supply[10] is used as an intermediate target. The current target is "ensuring the money supply growth in line with nominal GDP growth rate" see (National Bank of Ethiopia (NBE), 2009)

Operational Target: is the target set by the central bank in the purpose of linking the monetary policy tools for the attainment of the intermediate target. It involves the use of economic variables, which the Bank wants to effect on a day-to-day basis, through its monetary policy instruments. The growth of base money, which is also known as reserve money, is used as operational target.

3.1 Monetary Policy Instruments in Ethiopia

The financial history of Ethiopian shows that following the nationalization of private banks and other financial institutions in 1974 there were only few government banks operating throughout the country till 1994/5 namely Commercial Bank of Ethiopia, Construction and Housing Bank and Agricultural and Development Bank. During this period the National Bank of Ethiopia conduct its monetary policy by directly controlling monetary variables and prices.

The NBE set the interest rate structure in such a way that it discourages private sector and favors public institutions and specially cooperatives and associations. Accordingly, the private sector was charged the highest rate in all kind of loans. For example, Agricultural loan was 7 percent for private, 6 percent for state enterprises and 5 percent for cooperatives. The borrowing rate for private sector ranges from 7 percent to 10 percent, it was 4.5 percent to 8 percent for state enterprises but for cooperatives it ranges from 4.5 percent to 6 percent. The interest rate discrimination against private sector was not only in borrowing but also in deposit. The maximum rate, for instance, paid for private was 5.5 percent for time deposit over 5 years whereas it is 7.5 percent for others. For saving deposit in excess of Birr 100 thousands, interest rate was only 2 percent.

[10] This definition of money supply consists of narrow money (M1) plus Quasi-money (savings and time deposit), Overnight repurchase agreements and personal balance in money market accounts.

As a result of interest rate discrimination the effect can clearly be seen on credit shares, as the share of private sector in total loans was only 22.6 percent during 1988/89 and 1990/91 (NBE, 1990) Inflation averaging 9.7 percent during the command era, the real interest rate was negative. Moreover, private sector's investment was limited at Birr 500 thousands. Therefore, investment as well as saving by private sector was discouraged and hence the illegal market activities had a better way to engage in. As a result the whole investment activities in the country rested on inefficient and mismanaged public enterprises.

Following the change of government in 1991, the private sector was given emphasis and the government started to withdraw from the market step by step through privatizing its enterprises. This was part of the general economic liberalization process, which also touched the financial sector. Accordingly, National Bank of Ethiopia, along with the other three government banks, was restructured in a manner to conduct monetary policy independently and supervise financial institutions in the country (National Bank of Ethiopia (NBE), 2009).

The role of NBE in the financial sector grew following the establishment of private banks and insurances. (Annual report (NBE), 2014) The major financial institutions operating in Ethiopia are banks, insurance companies and micro-finance institutions. The number of banks operating in the country reached 19 of which 16 were private, and the remaining 3 state-owned. The slipping away of direct control power on money supply and the unpredictability of the private sector necessitated indirect controlling mechanism of money supply.

3.1.1 Reserve Requirement

The reserve requirement[11] is currently reduced from 10 to 5 percent of the net deposit in March 2013 (African Economic Outlook , 2014). And failing to comply with this requirement will be penalized. The NBE uses this instrument to control the liquidity of banks by varying the rate according with the targeted level. The higher Reserve Requirement contracts the liquidity as well as credit expansion power of commercial banks and the opposite will increase liquidity and credit expansion power of banks.

[11] Reserve requirement in Ethiopia is computed by netting out un-cleared checks paid and un-cleared effect foreign from the total deposits.

A decade ago reserve requirement was exceptionally bigger on Commercial Bank of Ethiopia (8 percent), by then which is the most liquid bank, in order to reduce the high lending potential of the Bank as well as the rise in inflow of foreign exchange following the coffee price boom. Since most of the export proceed during that time was coming through CBE and the high liquidity of the bank could have increased lending, it was logical to require the Bank a higher rate than other banks, which was 5 percent.

However, since the banks' asset in NBE doesn't earn interest but their liability bears interest it is mostly regarded as a tax and a high reserve requirement is thought to create disintermediation on the banking system. Consequentially, some countries such as Mexico and Canada have abolished it while others reduced it to the level that couldn't influence liquidity significantly and some central banks pay interest on banks required deposit. Today reserve requirement has little role and not frequently used in short-term money management (Gray, Hoggarth, & Place, 2000).

3.1.2 Open Market Operations

The conduct of OMO[12] varies from country to country depending on the legal and institutional setting, the structure of financial system and the stages of development in the securities market of the country (Darsi, 1991). Hence OMO in countries, like Ethiopia, where these institutional developments is not fulfilled is regarded as 'Open Market-type Operations' to distinguish it from those of the developed nations' OMO (Johnston & Sundararajan, 1999).

To develop market-based monetary instruments in underdeveloped financial market the first step would be primary issues of treasury bills[13] and central bank bills. (Darsi, 1991) Likewise in Ethiopia, bi-monthly treasury bills auction market is introduced in 1994/95 with the intention of financing government budget deficit from non-bank sources, to create a base for the establishment and development of secondary market and to boost the NBE's controlling power on money stock as well

[12] These includes, sale and purchase of government issued bond and securities, standing central bank credit facility and direct monetary policy tools, such required reserve, setting floor of deposit rate, repo, moral suasion and direct control on credit.

[13] Short-term (usually less than one year, typically three months) maturity promissory note issued by a national (federal) government as a primary instrument for regulating money supply and raising funds via open market operations.

as interest rate. However, the NBE, to bring monetary stability, also used individual bank credit ceiling side by side till the Treasury bills market gets strong.

Knowing that the acceptability of the market by the public will increase the efficiency of the OMO, measures were taken to hasten its development. Then the cut-off price and ceiling on some public enterprises was removed in order to allow them participate on a competitive basis. To increase the private sector participation, the minimum denomination was reduced from Birr 50 thousands to Birr 5 thousands and the interest proceed from the T-bills was exempted from income tax. Since then the market showed a slight improvement in attracting bidders, total demand for bills and volume of sale (Takele, 2013).

Despite these measures, the market failed to attract private bidders and it was, and still is, dominated by public organization both in number and volume of purchase. This phenomenon is a result of low interest rate in the treasury bills market, which on average is three-percentage point lower than the minimum deposit rate. This is due to high competition among liquid banks and other financial institutions making the treasury bills interest rate too small to attract private bidders who prefer depositing in banks rather than participate in the auction.

On the other hand, liquid commercial banks use the market as cost minimizing instrument, as they are willing to lend to the government by a lower rate than the deposit rate they are paying to their deposit liability resulting in lower interest rate. However, except providing fund for government, the treasury bills market is not serving most of its objectives it is established for. First, in an attempt to develop secondary market, NBE has allowed inter-bank money market but still it is at rudimentary level largely and ironically because of the treasury bills market, which cast a shadow on it development.

As the excessively liquid banks use treasury bills market that provides them with maximum security and lower cost as well as higher return (in absolute term) than inter-bank lending, they give fund seeking banks lesser attention and even turndown their request. Second, since around 60 percent of the treasury bills are purchased by commercial banks (Takele, 2013), that use their excess reserve and as the government spends this fund for short term financing like paying wages, it can be said that the treasury bills market in Ethiopia is inflationary as opposed to its objective.

Third, as the government financing is rested on few public institutions that participate in the auction, it might not be sustainable and an unexpected withdrawal of one or two bidders from the auction jeopardizes government financing. This is explained best by the January 2000 phenomena when a total of bills worth Birr 1100.0 million, one of the largest supplies, were put on tender but total demand unexpectedly was only Birr 131 million. This was due to the wrong signal from preceding auctions where there were usually excess demand but a withdrawal of a single bidder revealed the extent that the market is domination by few institutions.

Fourth, unlike the countries the other countries, the interest rate determined in the Treasury bills auction market in Ethiopia doesn't use to determine other rates in the economy. NBE conduct its OMO actively through Treasury bills market to influence the variables like liquidity level and net domestic assets of the banking system and money supply in the economy and monitor whether they are in conformity with the targeted level.

4 Baseline model

Under this section we provide the baseline theoretical model that is developed based on a seminar work by (Clarida, Gali, & Gertler, 1999). To analyze the monetary policy effect the New-Keynesian IS-LM framework with a Phillips curve that determine inflation is specified in this paper. The change in monetary policy which is usually in the form of an exogenous shift in monetary aggregate affect the money supply and result a change in interest so as to keep balance in the demand and supply. The change in interest rate will affect investment and consumption, which eventually result changes in important macroeconomic variables such as: price and output.

In many recent literatures, for instance see (Walsh, 2005), (Goodfriend, Marvin, & King, 1997) the effect of monetary policy is being modeled with dynamic stochastic general equilibrium (DSGE) framework. Following (Clarida, Gali, & Gertler, 1999) we adopt a simple general equilibrium model with slight modification, which excluded the assumption of prefect price flexibility and focused on the assumption of sticky price. The Empirical analysis built on a basic identification of Ethiopian economy. The welfare-maximizing objective of the central bank attained though choice of policy. Thus, the model detail consists: optimizing problems of agents, a mechanism of monetary non-neutrality and a source of monetary shock imparting on the economy. A non-detailed[14] aggregate relationships presented as follows.

Let: y_t be the actual output in logarithm;
z_t be the natural level of output in logarithm and
x_t be called the output gap

(Equation 4.1) $$x_t \equiv y_t - z_t$$

The baseline model represented in terms of an IS curve by (Equation 4.2) which shows a negative relationship between output gap and interest rate and a Phillips curve that show positive relationship between inflation and output gap. This

[14] For more detailed derivation see (Clarida, Gali, & Gertler, 1999), (Bernanke & Mihov, 1998) and (Walsh, 2005)

equation differ from the traditional IS curve, because current output depends on future's expected output and interest rate. A higher expected output of the next period raises the current output.

According to (Clarida, Gali, & Gertler, 1999), this is because of individuals' preferences to smooth consumption in response to higher next period consumption, which is associated with higher expected output. The intertemporal substitution of consumption captured by negative sign of real interest rate's coefficient.

Thus, the coefficient $-\varphi$ stands for the intertemporal elasticity of substation. The disturbance g_t is a function of expected change in government expenditure relative to expected changes in potential output. Changes in g_t correspond to shifts in the IS curve which can be referred to as demand shocks. This would also have been the case if we were abstracting using investments or private consumption.

Let: π_t be the period t inflation rate[15];
i_t be the nominal interest rate;
both expressed as a deviation from the longrun trend

(Equation 4.2) $$\boldsymbol{x_t = -\varphi[i_t - E_t\pi_{t-1}] + E_t x_{t+1} + g_t}$$

Where: E_t is the expectations operator;
$E_t\pi_{t+1}$ is the future expectation of inflation;
$E_t x_{t+1}$ is future expectation of the output gap;
$[i_t - E_t\pi_{t-1}]$ measures the real interest rate;
φ measures the interest elasticity in the IS curve and
g_t is a disturbance term

The following (Equation 4.3) depicted that a simple log-linearized approximation of the Phillips curve of the equilibrium aggregation of individual firm's pricing decisions, see (Clarida, Gali, & Gertler, 1999). In many economic literatures the equation referred to as "Expectation – Augmented" Phillips curve, it shows the relationship between inflation rate, output and expected inflation. The

[15] The inflation rate is defined as the percentage change in the price level from t-1 to t

distinction between expectation – augmented and the traditional Phillips curve is, the expected next period inflation ($E_t\pi_{t+1}$) is positively related to last time iflation, whereas the opposite is true in the traditional specification of Phillips curve.

(Equation 4.3) $$\boldsymbol{\pi_t = \theta x_t + \beta E_t \pi_{t+1} + \mu_t}$$

Forward iteration of (Equation 4.2) gives us (Equation 4.4), which could allow us to better understand how expectation about the future affects a current aggregate activity within the framework. (Equation 4.4) implies that the optimal gap depends not only on the real interest rate and demand shock, but also on the expected future paths of these two variables. Thus we can see that aggregate demand can be affected by expected as well as current monetary policy (in this case, measured by changes in interest rate).

(Equation 4.4) $$\boldsymbol{x_t = E_t \sum_{i=0}^{\infty} \{-\varphi[i_{t+i} - \pi_{t+1+i}] + g_{t+i}\}}$$

Likewise, a forward iteration of (Equation 4.3) gives us (Equation 4.5) in which we can understand that inflation is fully depends on current and future economic situations. Whereas, lagged inflation determines inflation in the traditional Phillips curve. In the following (Equation 4.5), the variable x_{t+i} captures a change in marginal cost associated whith variation in excess demand. On the other hand, μ_{i+i}, which is usually referred to us "cost-push", captures the exogenous shocks that may affect expected marginal cost.

Having these theoretical framework in which nominal interest rate play a role as a choice variable of monetary policy that we can link to the operational procedure of the National Bank of Ethiopia. With sticky prices assumption, innovations in the nominal interest rate immediately affects the real interest rate which causes agents to adjust their expectations and actions in such a way that output and prices are affected in the direction specified in the IS-LM model above.

(Equation 4.5) $$\boldsymbol{\pi_t = E_t \sum_{i=0}^{\infty} \beta[\theta x_{t+i} + \mu_{i+i}]}$$

The last equation provides the Central Bank's objective function, which translates the behavior of the target variables into a welfare measure to guide policy choices. Following contemporary practice, we assume the Central Bank's objective function is over an inflation target and an output target and takes the form:

(Equation 4.6) $$\boldsymbol{max} -\frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{E_t}\{\sum_{\boldsymbol{i=0}}^{\boldsymbol{\infty}}\boldsymbol{\beta}[\boldsymbol{\alpha x_{t+i}^2}+\boldsymbol{\pi_{t+i}^2}]\}$$

Where:

α	is a relative weight assigned to the output deviation
$E_t\pi_{t+1}$	is the future expectation of inflation;
E_tx_{t+1}	is future expectation of the output gap;
$[i_t - E_t\pi_{t-1}]$	measures the real interest rate;
φ	measures the interest elasticity in the IS curve and
g_t	is a disturbance term

The objective function takes the potential output of the economy z_t as the target output and implicitly takes zero as the target inflation rate. The relative weight to be assigned to output deviation α has been a vague issue in the economic literatures. Following (Bernanke & Mishkin, 1997) there seems consensus among economist that the primary objective of monetary policy should be price stabilization than to target output.

Accordingly, the National Bank of Ethiopia has three fundamental objectives, such as maintaining price and exchange rate stability, and support sustainable economic growth. Even though, the Bank has not yet announced a numerically specified implicit output target, it has preferred to keep it among its objectives. Although inflation targeting in the developing economies, requires sustained stimulation of aggregate demand, we put much emphasis to inflation targeting following (Chuku, 2009).

5 Empirical Methodology

5.1 The Benchmark SVAR Specification

Having specified the theoretical model and a priori-expectation in the subsequent section, the benchmark structural VAR model that is used in the analysis of the effectiveness of monetary policy in Ethiopia has the following econometric representation.

(Equation 5.1) $$\boldsymbol{Y_t = C_t + \sum_{k=1}^{n} A_t Y_{t-k} + \sum_{k=1}^{n} B_t Y X_{t-k} + u_t}$$

Where: C_t is a vector of constant term;
Y_t is the vector of endogenous variables;
X_t is a vector of exogenous variables;
A_t and B_t represent a matrix of coefficients and
u_t is a vector of innovations

The vector of exogenous variables contains constant term, international oil price and a dummy variable, which capture structural break in the economy. The points of structural break have been identified by Zivot-Andrews test in Eviews; See Table 5.3 in the section below.

(Equation 5.2) $$\boldsymbol{X_t' = [D_t^{str} \;\; O_t^{oil}]}$$

These exogenous variables are used in empirical model specification to control for the change in economic condition of Ethiopia economy and external factors that the National Bank has been claiming for higher inflation in the recent few years. We try to capture the supply shock using international oil price. We also allow for a contemporaneous impact of the exogenous variable on the endogenous variables.

We consider a five variable SVAR model of the joint dynamics including the following variables: gross domestic product GDP (y_t), consumer price index CPI (p_t), money supply measured by broad money M2 (m_t), interest rate (i_t) and real effective exchange rate REER (r_t). It could not be vague that monetary development has played a central role in the economy of a country. Therefore the inclusion of a monetary aggregate could be helpful in identifying the channel of monetary policy transmission. Furthermore, along with the main policy variables, the paper has tried to investigate the effect of real effective exchange rate in the block of endogenous variables. The SVAR isolates structural shocks by imposing restrictions on the long-run behavior of the variables in the model, and these long-run restrictions are derived directly from the underlying economic models. In addition, interest rates (lending rate) are not considered as a particular variable in the model, its behavior over time is reflected through the time series nature of the structural VAR. Thus, the vector of endogenous variables in our model can be written as;

(Equation 5.3) $$\boldsymbol{Y_t' = [y_t\ p_t\ r_t\ m_t\ i_t\ ]}$$

A monetary shock is identified through a contemporaneous, recursive system in which innovations are assumed to be orthogonal and the variables ordered as in (Equation 5.3), as outlined by (Sims & Zha, 1998), (Sims C. A., 1980) and (Sims C. A., 1992). The representation in (Equation 5.4) depicts the structural representation of the VAR that describes the effects of exogenous shocks by the means of impulse response analysis.

(Equation 5.4) $$\boldsymbol{\Omega Y_t = \Omega A(L) Y_{t-1} + B(L) X_t + e_t}$$

Where Ω represents a matrix of the contemporaneous relationship between the variables, e_t denotes the vector of structural shocks, which is a shock to a variable that is orthogonal to the other shocks in the economy.

(Equation 5.5) $$\boldsymbol{\Omega e_t = u_t}$$

Pre-multiplying (Equation 5.4) by the inverse of the matrix denoting the contemporaneous relationship, gives the relationship between the reduced from innovation and the structural shocks e_t. For the sake of convenience to present it within paragraph, the vector of structural shocks denoted as $[e^y\ e^p\ e^r\ e^m\ e^i\ ]'$. Afterward the logical step is to specifiy our identifying restriction based on baseline theoretical models and particular economic reasoning that are specific to Ethiopia economy.

5.1.1 Identifying restriction

As can be clearly referred from the theoretical model specification in the above section, we have identified a prior-expectation following the prepositions in the standard Mundell-Fleming-Dornbush model see (Equation 4.2). The model assumes, expansionary monetary policies reduce interest rates, real exchange rate depreciates and price and output eventually increases.

The following (Equation 5.6) summarize the relationship in which output (Gross Domestic Product) and price (consumer price) respond to shocks to monetary aggregate (broad money), interest rates and the real effective exchange rate.

For instance, the second equation in the matrix bellow (second row of matrix Ω), we allow price to contemporaneously respond to supply shock in output (supply shocks due to Change in the international oil price and climate condition are practically significant causes of supply shocks in Ethiopia). Likewise, the interpretation of the third equation can be that broad money supply is allowed to respond contemporaneously to shocks to output, consumer price, interest rate and effective exchange rate.

The fourth equation represents the monetary policy reaction function. Since the National Bank has listed economic growth as its main goal, then we intuitively suspect interest rate to contemporaneously respond to shock in the output. Finally the fifth equations suggest that the exchange rate do not contemporaneously respond to any variables.

(Equation 5.6)

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & \alpha_{34} & \alpha_{35} \\ 0 & \alpha_{42} & 0 & 1 & 0 \\ 0 & 0 & \alpha_{53} & 0 & 1 \end{bmatrix} * Y_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & \alpha_{34} & \alpha_{35} \\ 0 & \alpha_{42} & 0 & 1 & 0 \\ 0 & 0 & \alpha_{53} & 0 & 1 \end{bmatrix} A(L)Y_{t-1} + \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} (L)X + \begin{bmatrix} e^y \\ e^p \\ e^r \\ e^m \\ e^i \end{bmatrix}$$

A matrix representation of (Equation 5.5) can be presented as follow;

(Equation 5.7)

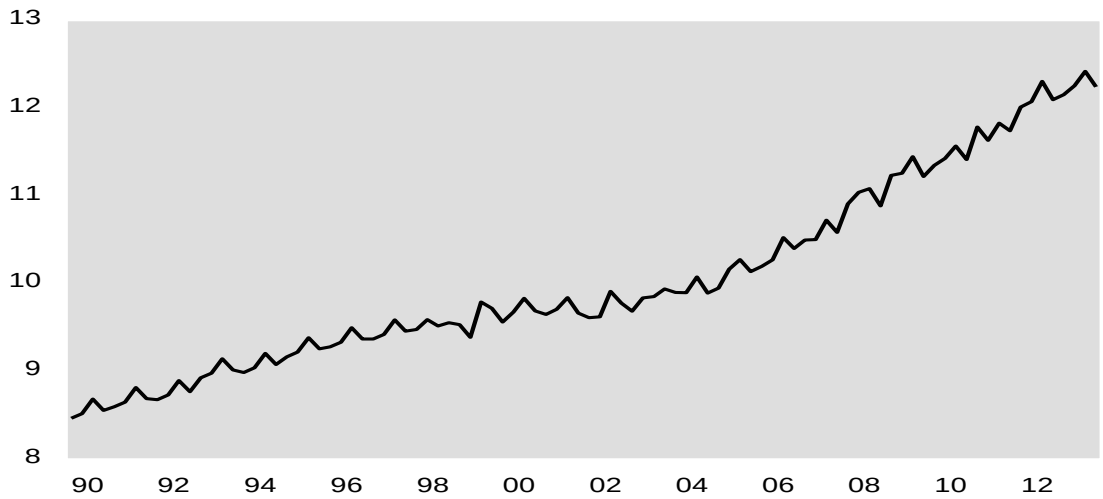
$$\begin{bmatrix} u^y \\ u^p \\ u^r \\ u^m \\ u^i \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & \alpha_{34} & \alpha_{35} \\ 0 & \alpha_{42} & 0 & 1 & 0 \\ 0 & 0 & \alpha_{53} & 0 & 1 \end{bmatrix} \begin{bmatrix} e^y \\ e^p \\ e^r \\ e^m \\ e^i \end{bmatrix}$$

5.2 Data Overview

To quantitative measure the effect of monetary policy shocks on output and general prices we estimate SVAR model for Ethiopia. Which is estimated using quarterly data of the selected variables for the sample period of 1990:1-2013:4 that are treated for the seasonal variability, see (5.3.3). Since 1991 change of government, the country has experienced radical shift in the sphere of political economy. We believe economic analysis of this period can provide meaningful information in the study of evaluation of monetary policy. The choice of this sample period was not arbitrary, in a way, it is not only based on the availability of well-organized macroeconomic database on the country, but also takes into account the fact that the era is marked as market based monetary regime in Ethiopia.

The dataset used in this paper are obtained from official databases of the National Bank of Ethiopia (NBE), IMF's International Financial Statistics and the World Bank commodity price database. The country's Central Statistical Agency does not publish quarterly data on gross domestic production (GDP). Thus, we have used interpolation of annual GDP into quarterly series, taking into consideration the difference in relative weight of production due to seasonal variation across the quarters in the year. In the following (Figure 5.1) we can observe the time series plot of interpolated quarterly real GDP series.

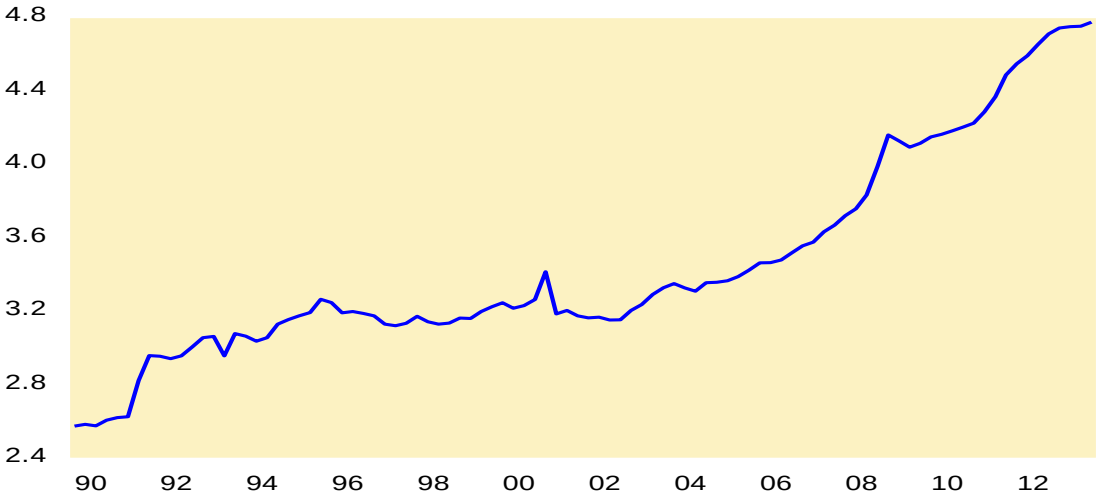
Figure 5.1: logarithm of Quarterly Gross Domestic Product



Source: author's computations.

The variables and their measurement used in this study are the following. The real economic activity is measured by quarterly data of real Gross Domestic Product (RGDP). Quarterly data on the Consumer Price Index (CPI) captured nominal general price changes, development of quarterly national consumer price index over the sample period is presented in the (Figure 5.2) below.

Figure 5.2: Logarithm of Consumer Price Index (CPI)

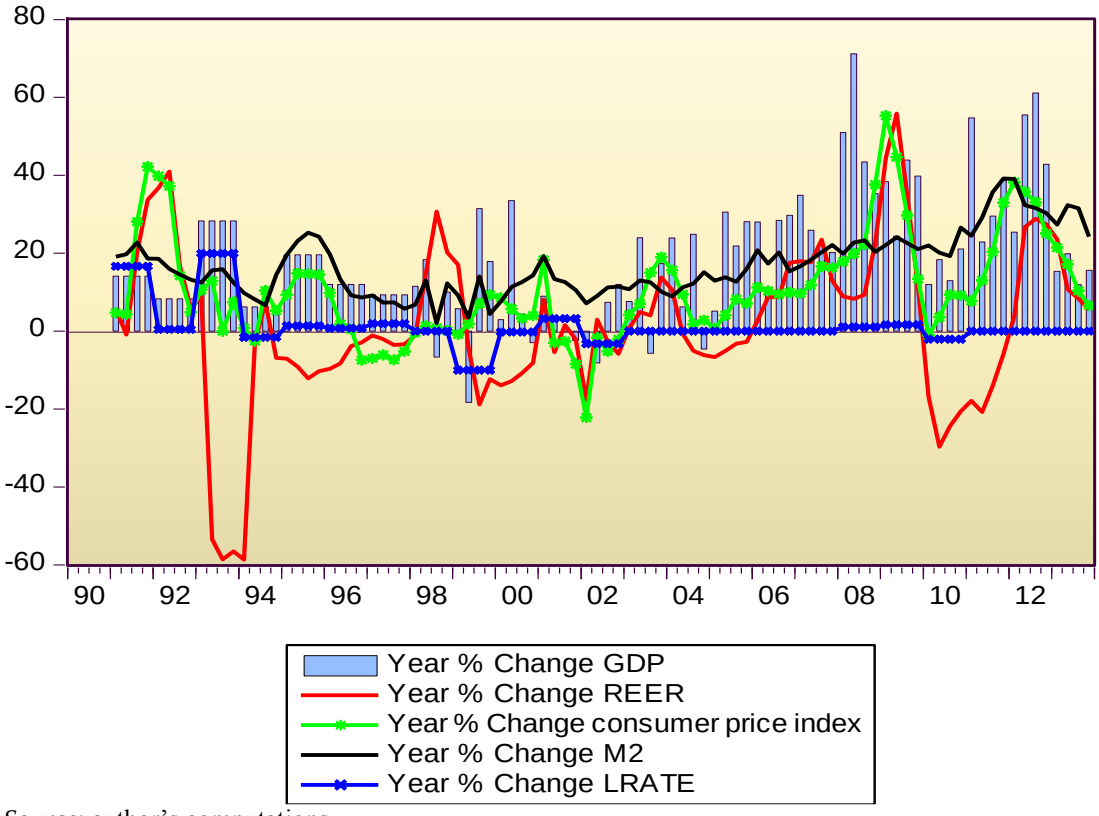


Source: author's computations.

Broad money supply measured by the quarterly data of M2, served as a quantity-based monetary policy variable. The price based monetary policy instrument captured by lending interest rate and real effective exchange rate (REER).[16] REER is incorporated to serve as another price-based monetary policy variable and computed as a trade-weighted index with inflation differential.

[16] The real effective exchange rate (REER) acts as a "pass-through" channel, that is, a component of the cost of imported items and helps to capture the traditional interest rate paradigm, where monetary policy has the immediate effect of changing the returns on assets denominated in other currencies.

Figure 5.3: Development of variables over time in percentage change



Source: author's computations.

Moreover, the quarterly International oil price data is used to proxy a supply shock to the country's economy. All variables incorporated into the model are in their natural logarithm, refer to the appendix part (Figure 0.1), this is to enable us index all the variables and to aid interpretation of results.

Table 5.1 shows the descriptive statistics of all variable, a general picture in the movement of our variable can also clearly be seen in the above Figure 5.3, it is noticeable that the country has been registering a substantial growth in terms of gross domestic production. At the same time its growth performance has been challenged by macroeconomic problem of high inflation until quite recently, until the National Bank reported single digit inflation.

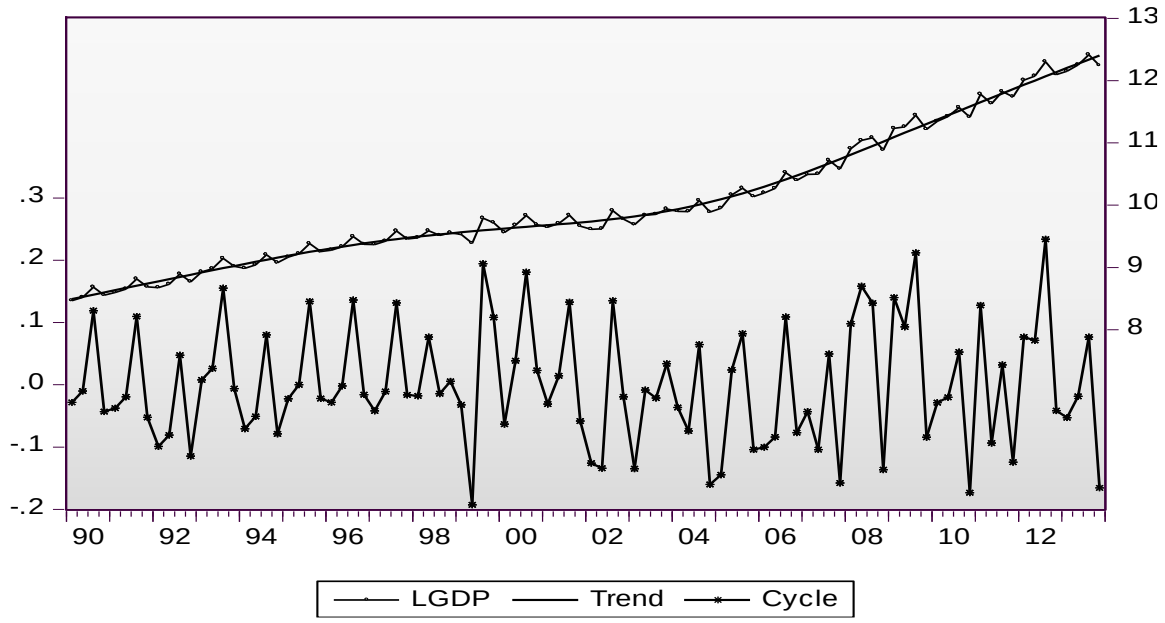
Table 5.1: Summary of descriptive statistics

	OIL	Y	M2	REER	CPI	LRATE
Mean	44.40	43346.16	47074.20	136.1534	37.84527	12.1624
Maximum	120.97	246611.6	235313.6	307.6086	118.5489	15.4772
Minimum	11.79	4750.919	5814.800	90.82616	13.13295	6.7000
Std. Dev.	32.84	56575.76	53342.14	51.23791	26.89132	1.9595
Skewness	0.92	1.976152	1.910307	1.790486	1.738327	-0.5330
Kurtosis	2.39	6.005644	5.961839	5.622405	4.993867	3.9877
Jarque-Bera	15.04	98.61842	93.47834	78.80146	64.25054	8.4496
Probability	0.001	0.000000	0.000000	0.000000	0.000000	0.014

Source: author's computations.

We would like to note that our preferred measure of economic activity is a quarterly data of real gross domestic product (RGDP). For the sake of comparison and robustness check, we had also performed the same empirical analysis using the logarithm of the output gap that we use in our baseline specification. The output gap is an abstract concept as there is no means to measure the actual output gap, hence we employed a commonly used method to estimate the output gap using (Hodrick & Prescott, 1997) see Figure 5.4 below. Due to the fact that the impulse response produced using both output gap and RGDP have suggested fairly similar result see (Figure 0.2) in the appendix part, we therefore opted to stick to RGDP to measure real economic activity in Ethiopia.

Figure 5.4: Logarithm of Output gap estimate using H-P[17] Filter (Lambda = 1600)



Note: Natural Logarithm of quarterly RGDP Data. The output gap is the average difference between real output and potential output, measured as a fraction of potential output using seasonally adjusted data. The use of lambda =1600 widely suggested in scientific literatures for H-P estimation using quarterly data see (Hodrick & Prescott, 1997).

Source: author's computations.

[17] The H-P filter is an algorithm that "smooths" the original time series y_t to estimate its trend component, τ_t. The cyclical component is, as usual, the difference between the original series and its trend.

5.3 Preliminary Statistical test

5.3.1 Test for unit root

Any series that is not stationary is said to be non-stationary. A differenced stationary series is said to be integrated and is denoted as $I(d)$ where d is the order of integration. The order of integration is the number of unit roots contained in the series, or the number of differencing operations it takes to make the series stationary. For the random walk above, there is one unit root, so it is an $I(1)$ series. Similarly, a stationary series is $I(0)$.

Standard inference procedures do not apply to regressions, which contain an integrated dependent variable or integrated regressors. Therefore, it is important to check whether a series is stationary or not before using it in a regression. The formal method to test the stationarity of a series is the unit root test. Hence, to examine the stationarity of our variables we used a variety of powerful tools, made available in Eviews for testing for the presence of a unit root.

Table 5.2: summary result of stationary test

The Variables[18]	Augmented Dickey-Fuller (ADF)	Philips-Perron	Kwiatkowski-Philips-Schmidt-Shin (KPSS)	Ng-Perron
CPI	I(1)*[19]	I(1)	I(1)	I(1)*
GDP	I(1)**	I(1)	I(1)	I(1)**
Broad money (M2)	I(1)***	I(1)	I(2)	I(1)*
REER	I(1)*	I(1)	I(0)	I(1)*
Interest rate (LRATE)	I(0)*	I(0)	I(0)	I(1)*
Oil Price	I(1)*	I(1)*	I(1)*	I(1)*

Source: author's computations.

The reason behind the assortment of tests is to obtain reliable and consistent results. Thus, in addition to the common tests of Dickey-Fuller and Phillips-Perron, we also employ the Ng-Perron (NP) test and the Kwiatkowski, Phillips, Schmidt and Shin's (KPSS) test designed to overcome the problems of low power and size distortions integral in the traditional tests see (Maddala & Kim, 1998). We feed our

[18] Note that all variables are in the Natural logarithm form.

[19] The symbol ***, **, * represents statistical significance at significant level of 10%, 5%, 1% respectively.

variables into SVAR model according to their order of integration in which they become stationary.

Table 5.2, present the results obtained for each variable from the various methods used to test the hypothesis of unit root or no unit root as the case may be. With the exception of the interest rate (lending rate), all other variables have a unit root and come to be stationary only after we transformed them to their first differences. The stationarity test results make us to have a reliable guide on how to incorporate the variables in our SVAR model. Based on our results, we feed RGDP, CPI, REER, and M2 into the model in their first difference, while interest rate (LRATE) enters at its level.

5.3.2 Structural Break

A structural break is a notion in Econometrics and it appears when we see an unexpected shift in a (macroeconomic) time series. The inability to capture this factor into the model can lead to huge forecasting errors and unreliability of result in general. For the purpose of capturing the effect of structural break in the economy, we introduce a dummy variable (D_t^{str}) into our model as an exogoneous variable along with the international oil price which is another exogenous variable affecting inflation level of import dependent economy like Ethiopia.

Structural break tests help us to identify when there is a significant change in our data. In this study, we used a procedure suggested by (Zivot & Andrews, 1992) which allow for structural breaks under the alternative hypothesis of the unit root test and additionally allow for breaks in level and trend, the selected breakpoint is summarized in the following Table 5.1, for a detailed result from Eviews see Table 0.2 in the appendix part.

Table 5.3: Test for Structural Break using Zivot-Andrew[20]

Variables	Choosen Break point	Remark
CPI	2007Q1	all are statistically significant at 1 % critical value
GDP	2007Q2	
Broad money (M2)	2008Q3	
REER	1996Q4	
Interest rate (LRATE)	1999Q1	

Source: author's computations.

5.3.3 Seasonality

It is a frequent case for the economic data observed at quarterly and monthly frequencies to exhibit cyclical movements that recur every month or quarter. We believe it is rational to suspect the presence of seasonality in our data. The Ethiopian economy has been identified as an agrarian economy in which a substantial part of the national output is being contributed by the agricultural sector. This sector of the economy is best known as heavily reliant on rain, thus the economy has been suffering from supply shock induced by the seasonality of rain, thereby this effect reflected onto the general consumer price level via demand and supply interplay.

[20] Note: Since Probability values are calculated form a standard t-distribution and we do not take it into account when selecting the breakpoint with Zivot-Andrew test.

Figure 5.5: Percentage change of consumer price index by season

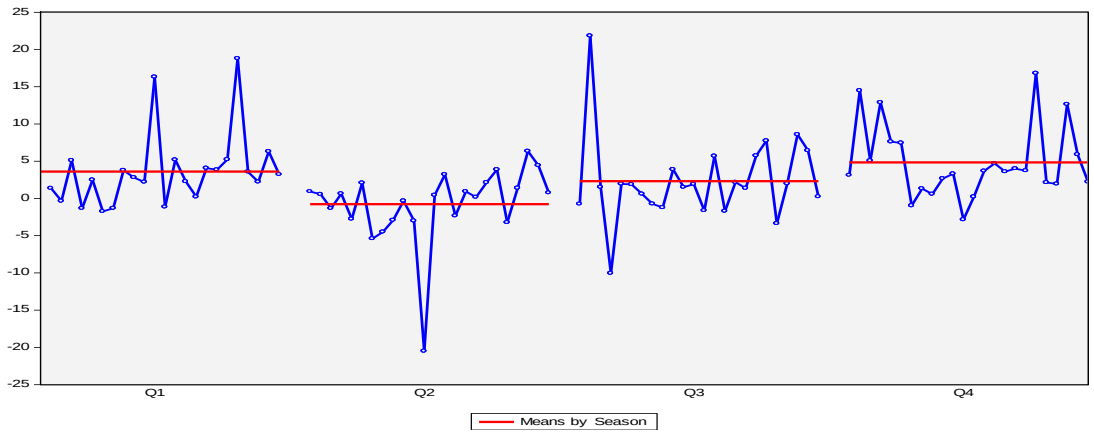
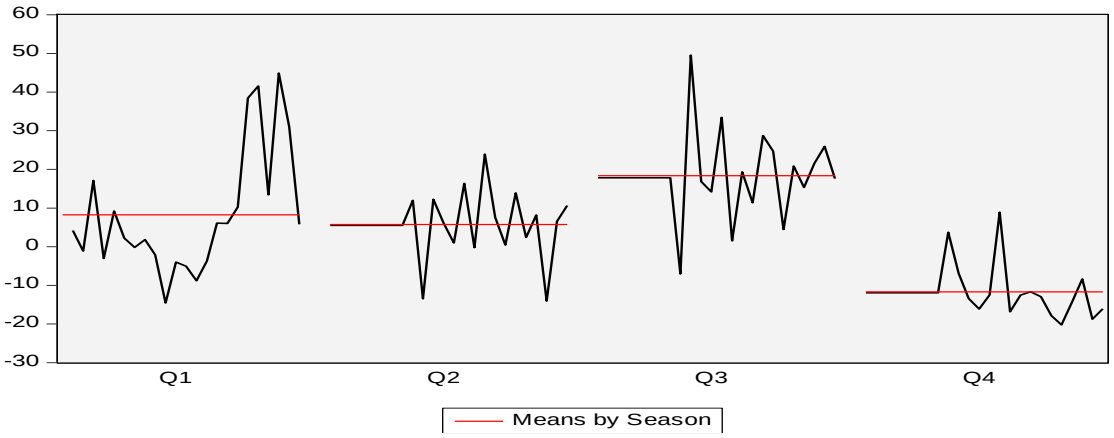


Figure 5.6: Gross Domestic Product (GDP) by season



Source: author's computations.

Figure 5.5 and Figure 5.6, above shows mean variation of GDP and CPI across quarters in a year. We used a seasonal dummy variable (SEAS_DUMY) to pick out and control for seasonal variation in the data. The idea is to include a set of dummy variables for each quarter, which will then net out the average change in a variable resulting from any seasonal fluctuations.

6 Estimation Result and Discussion

6.1 Lag Order Selection

As for the lag structure, based on the Hannan-Quinn information criterion (HQ) and Final prediction error (FPE) the selected lag order is 3. Unlike HQ and FPE, Akaike Information Criterion (AIC), sequentially modified (LR) and Schwarz information criterion (SC) test found that the favorable lag length to be 7, 8 and 2 respectively, see (Table 6.1) below. We selected 3 as an appropriate lag length to estimate the VAR model, because it is indicated by two information criterions while other selected only by information criteria. The selection of this lag length satisfied the conditions of no autocorrelation among residuals, the stability of the VAR model and the joint significance of all the lags in the model.

Table 6.1: VAR Lag Order Selection Criteria

Endogenous variables: D(LY) D(LCPI) D(LM2) LRATE D(LREER)
Exogenous variables: C D(LOIL) DSTR SEAS_DUMY

Lag	LogL	LR[21]	FPE	AIC	SC	HQ
0	516.8000	NA	7.55e-12	-11.42069	-10.85381	-11.19243
1	607.4113	162.4754	1.68e-12	-12.92899	-11.65352	-12.41540
2	674.5050	112.5940	6.43e-13	-13.89667	-11.91260*	-13.09774
3	**721.6409**	**73.68370**	**3.95e-13***	**-14.40554**	**-11.71288**	**-13.32129***
4	741.6359	28.95837	4.60e-13	-14.29048	-10.88923	-12.92090
5	758.5624	22.56859	5.88e-13	-14.10488	-9.995035	-12.44997
6	792.5240	41.37857	5.22e-13	-14.31090	-9.492456	-12.37066
7	834.7371	46.58001*	3.98e-13	-14.70660	-9.179566	-12.48103
8	861.5600	26.51457	4.52e-13	-14.74851*	-8.512877	-12.23761

* indicates lag order selected by the criterion

Source: author's computations.

[21] Where: AIC: Akaike information criterion
LR: Sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 6.2: Vector Auto regression Estimates[22]

	D(LY)	D(LCPI)	D(LM2)	LRATE	D(LREER)
D(LY(-1))	-0.709611	0.133537	0.103857	0.066814	0.062730
	(0.10132)	(0.05559)	(0.03310)	(0.05985)	(0.09859)
	[-7.00394]	[2.40215]	[3.13723]	[1.11644]	[0.63624]
D(LY(-2))	-0.417126	0.134156	0.161730	0.091004	0.006961
	(0.10506)	(0.05764)	(0.03433)	(0.06206)	(0.10224)
	[-3.97046]	[2.32734]	[4.71144]	[1.46649]	[0.06809]
D(LY(-3))	-0.417191	0.071233	0.066030	0.035024	0.038799
	(0.09319)	(0.05113)	(0.03045)	(0.05505)	(0.09069)
	[-4.47662]	[1.39307]	[2.16843]	[0.63625]	[0.42782]
D(LCPI(-1))	0.339430	-0.067103	0.122899	-0.015942	-0.188727
	(0.22726)	(0.12469)	(0.07425)	(0.13424)	(0.22115)
	[1.49360]	[-0.53815]	[1.65510]	[-0.11876]	[-0.85338]
D(LCPI(-2))	0.522580	0.054952	-0.044932	-0.048196	0.252317
	(0.22375)	(0.12277)	(0.07311)	(0.13217)	(0.21774)
	[2.33551]	[0.44760]	[-0.61458]	[-0.36466]	[1.15878]
D(LCPI(-3))	0.187651	-0.225665	-0.126011	-0.094202	-0.116215
	(0.23394)	(0.12836)	(0.07644)	(0.13818)	(0.22765)
	[0.80215]	[-1.75810]	[-1.64855]	[-0.68172]	[-0.51049]
D(LM2(-1))	-0.536753	-0.041421	-0.225777	-0.360389	0.269585
	(0.38774)	(0.21275)	(0.12669)	(0.22903)	(0.37733)
	[-1.38430]	[-0.19469]	[-1.78208]	[-1.57353]	[0.71446]
D(LM2(-2))	0.162307	0.057295	0.049202	0.381815	-0.495850
	(0.36724)	(0.20150)	(0.11999)	(0.21692)	(0.35737)
	[0.44197]	[0.28434]	[0.41005]	[1.76016]	[-1.38749]
D(LM2(-3))	1.666396	0.525528	0.254506	0.059140	0.767322
	(0.36305)	(0.19920)	(0.11862)	(0.21445)	(0.35329)
	[4.59004]	[2.63822]	[2.14550]	[0.27578]	[2.17190]
LRATE(-1)	0.305735	-0.178054	0.005424	0.613244	-1.189162
	(0.17759)	(0.09744)	(0.05803)	(0.10490)	(0.17282)
	[1.72161]	[-1.82734]	[0.09348]	[5.84612]	[-6.88107]
LRATE(-2)	-0.260948	0.187857	-0.007865	-0.035056	1.491189
	(0.24712)	(0.13559)	(0.08075)	(0.14597)	(0.24048)
	[-1.05596]	[1.38547]	[-0.09740]	[-0.24016]	[6.20083]
LRATE(-3)	0.034234	-0.084484	-0.012258	0.111306	-0.374733
	(0.19396)	(0.10642)	(0.06338)	(0.11457)	(0.18875)
	[0.17650]	[-0.79384]	[-0.19342]	[0.97151]	[-1.98531]
D(LREER(-1))	-0.166635	0.110793	-0.018994	-0.000754	0.312056
	(0.12069)	(0.06622)	(0.03943)	(0.07129)	(0.11744)
	[-1.38075]	[1.67315]	[-0.48168]	[-0.01058]	[2.65708]
D(LREER(-2))	-0.102340	-0.140688	0.017233	0.020567	-0.163705
	(0.10049)	(0.05514)	(0.03283)	(0.05936)	(0.09779)
	[-1.01843]	[-2.55165]	[0.52484]	[0.34650]	[-1.67406]
D(LREER(-3))	0.096171	0.064004	0.041470	0.060991	-0.018169
	(0.10492)	(0.05757)	(0.03428)	(0.06197)	(0.10210)
	[0.91665]	[1.11185]	[1.20972]	[0.98417]	[-0.17796]
C	-0.140850	0.182912	0.066811	0.694309	0.180512
	(0.19169)	(0.10518)	(0.06263)	(0.11323)	(0.18654)
	[-0.73479]	[1.73910]	[1.06671]	[6.13203]	[0.96769]
SEAS_DUMY	0.026024	0.021393	-0.012211	0.026446	0.011998

[22] Note that Standard errors in ( ) & t-statistics in [ ]

	(0.03755)	(0.02060)	(0.01227)	(0.02218)	(0.03654)
	[0.69311]	[1.03843]	[-0.99536]	[1.19244]	[0.32836]
DINTR	-0.006165	-0.000911	-0.000588	0.013022	-0.003397
	(0.00437)	(0.00240)	(0.00143)	(0.00258)	(0.00425)
	[-1.41173]	[-0.38032]	[-0.41218]	[5.04808]	[-0.79935]
D(LOIL)	0.056551	-0.064430	0.003469	-0.049450	-0.179676
	(0.07487)	(0.04108)	(0.02446)	(0.04423)	(0.07286)
	[0.75530]	[-1.56834]	[0.14181]	[-1.11812]	[-2.46600]
R-squared	0.696247	0.364468	0.360803	0.872399	0.535681
Adj. R-squared	0.621348	0.207761	0.203193	0.840935	0.421192
Sum sq. resids	0.576093	0.173436	0.061505	0.201004	0.545561
S.E. equation	0.088835	0.048743	0.029026	0.052474	0.086449
F-statistic	9.295915	2.325795	2.289216	27.72745	4.678866
Log likelihood	102.8283	158.0495	205.7371	151.2638	105.3332
Akaike AIC	-1.822353	-3.022814	-4.059502	-2.875301	-1.876808
Schwarz SC	-1.301549	-2.502010	-3.538697	-2.354497	-1.356004
Mean dependent	0.040037	0.023564	0.038669	2.509175	-0.002217
S.D. dependent	0.144366	0.054762	0.032518	0.131569	0.113630
Determinant resid covariance (dof adj.)		2.24E-13			
Determinant resid covariance		7.06E-14			
Log likelihood		740.2426			
Akaike information criterion		-14.02701			
Schwarz criterion		-11.42299			

Source: author's computations.

6.2 Serial correlation / Misspecification Test

Table 6.3, reports the multivariate LM test statistics for residual serial correlation up to 8 lags. And the test result shown below, confirm that there is no serial correlation of residuals in our model for lag order of 3, i.e. the test statistics does not reject the null hypothesis that no serial correlation at 3 lag.

Table 6.3: VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	39.49279	0.0329
2	18.33122	0.8280
3	**35.16432**	**0.0853**
4	27.38825	0.3368
5	22.17731	0.6255
6	25.87818	0.4141
7	19.79190	0.7577
8	33.59896	0.1168

Probs from chi-square with 25 df.

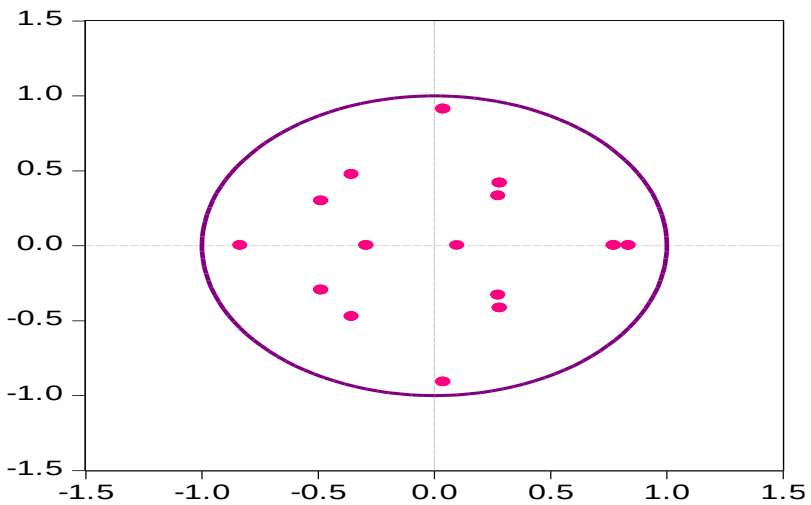
Note: Null Hypothesis: no serial correlation at lag order h

Source: author's computations.

6.3 Model Stability

Figure 6.1, reports the inverse roots of the characteristic AR polynomial. The estimated VAR is stable (stationary) if all roots have modulus less than one and lie inside the unit circle. Thus, our interpretation based on the impulse response generated from the SVAR model is valid because the model is confirmed to be stable. If the VAR is not stable, certain results (such as impulse response standard errors) are not valid.

Figure 6.1: VAR model stability test using Inverse Roots of AR Characteristics Polynomial



Source: author's computations.

6.4 Estimated Response of Output and Price to Monetary innovation

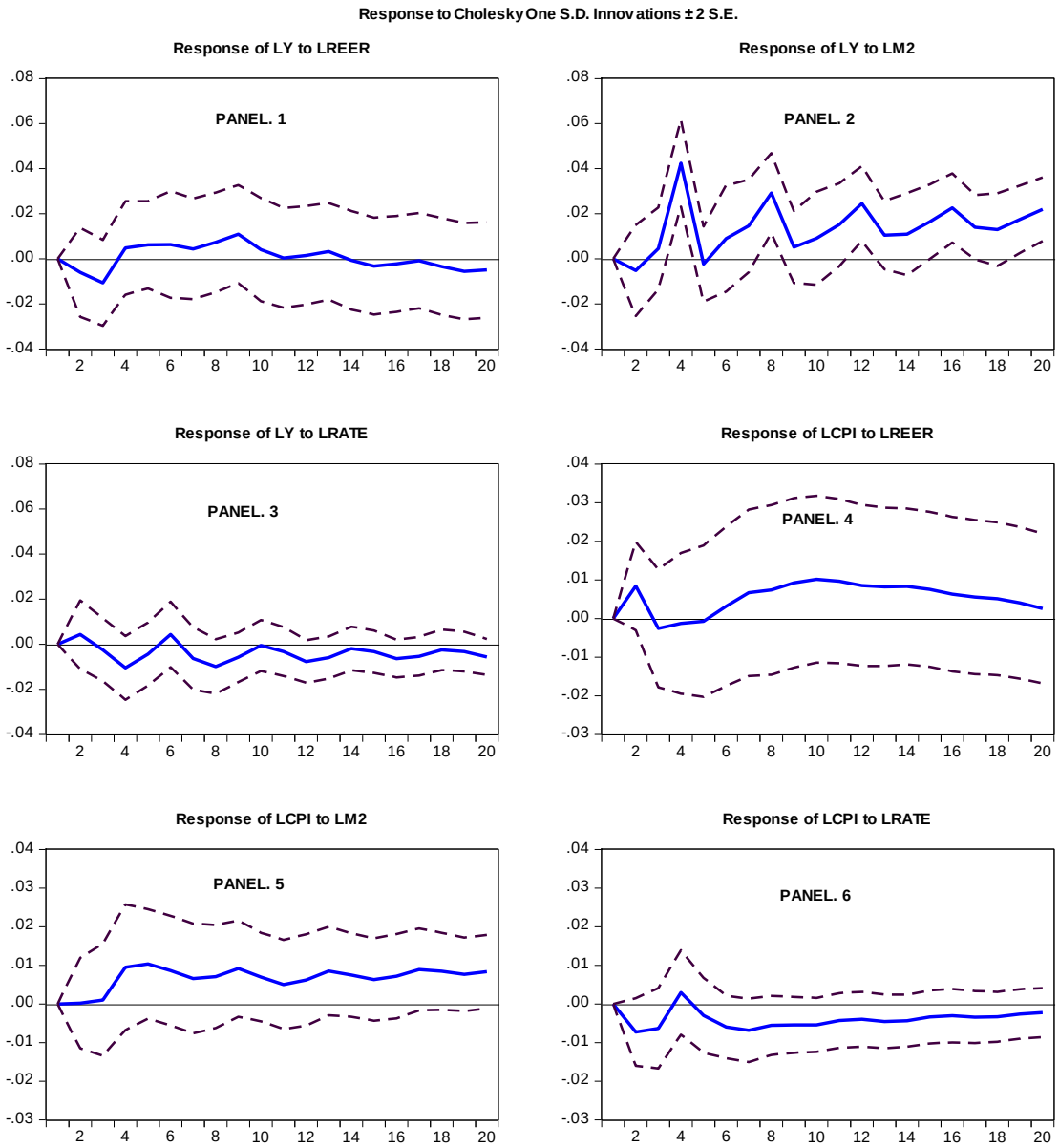
In this part of the paper, we have tried to demonstrate the estimated effects of innovations in monetary policy variables on output and prices. The coefficients of our vector autoregressive (VAR) model are numerous more than 70, can be seen in the above Table 6.2 and not readily subject to interpretation. Hence, the interpretation follows from the path of the impulse response functions[23] generated from the recursively-orthogonalized SVAR estimated residuals. The impulse responses show the path of output and prices when there are innovations in the policy variables.

The following (Figure 6.2) comprises of six panels of impulse response graphs, indicating how innovations in respective monetary policy variables affect real output and prices in Ethiopia over a time horizon of 20 quarters (five years). Each panel illustrates the response of the non-policy variable to a one standard deviation innovation (corresponding to a positive shock) in the monetary policy variable.

Non-effectiveness of the monetary policy on non-policy variables is shown by a value of zero and the variable remains on the same path it would have taken had there been no shock to monetary. A positive or negative value indicates that the shock would cause the variable to be above or below its "natural" path as the case may be. The solid lines depict the estimated effects, while the broken lines represent the boundaries of a 95% confidence interval of response standard errors.

[23] A shock to the *i*-th variable not only directly affects the *i*-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables.

Figure 6.2: Response of Output and Price to Monetary Policy Innovations



Source: author's computations.

Panel 2 of (Figure 6.2) above, presents the response of real GDP to an expansionary shock in the money supply, measured by broad money supply (M2). Here, output declines quickly but insignificantly within the first two quarters, start to rise up from the third quarter and reach maximum point in the forth quarter then decline again but stayed positive, eventually follow some cyclical pattern. Although, the response of output to money growth insignificantly negative during the first two quarter, on average it stays positive over the time horizon under consideration, i.e. persistent. Thus, we could say, this response is highly consistent with our a priori expectation as presented in the traditional Keynesian IS-LM model and the Mundell-Fleming-Dornbusch model.

The time dynamics are fairly intuitive, especially in the perspective of the least developed economies like Ethiopia where factors of production characterized by a rigid nature. Economic agents are expected to adjust their spending and investment habits moderately and gradually in response to the increased supply of funds rather than immediately. But, the immediate response established in the study of (Chuku, 2009) for the case of Nigeria is rather counter intuitive. The result from our study complies with the finding of (Olivei & Tenreyro, 2007) who investigated a delayed and persistent response of Japan economy against monetary innovation in the 80's.

In panel 3, we can note that a positive innovation in the interest rate, i.e. corresponds to a contractionary monetary policy, has a slight positive but insignificant effect on the real GDP during the first two quarters and then it persistently remained negative except in the sixth quarter where it becomes positive once again and eventually approach to its natural path. Likewise, this response is in line with our theoretical expectations. Compared to a shock to the stock of money supply, a shock to interest rate has brought relatively a tiny response onto real GDP in terms of magnitude. This could be attributed to a simple fact that there are underdeveloped credit markets in the economy. The finding of (Ganev, Gregory, Krisztina, & Krzysztof, 2002) which found no indication that interest rate affect real output for the Central and Eastern European countries including the Czech Republic, contradict with our result.

In panel 1, we can observe that a positive innovation in the real exchange rate (REER), i.e. a real depreciation is approximately four quarters delayed to affect the real output in the expected direction. But, the positive effect of a real depreciation began to set in during the fourth quarter and persist for some period and converges to its natural path. This response is as well in line with our theoretical expectation especially for an open economy with expanding foreign sector like Ethiopia.

In panel 5. The price effect of shocks to the monetary policy in Ethiopia is denoted. As is the case for the response of output, price also respond to a positive shock to money supply after certain period of lag, approximately two quarters. From the second quarter onwards an increase in the monetary aggregate (M2) leads to sustained increase in prices. Unlike (Chuku, 2009), the delayed response in our study suggests that prices are relatively rigid; therefore the sticky price assumption for the basic Keynesian IS-LM models may be effective in Ethiopia.

Panel 6. Presents that a positive innovation to interest rate (contractionary monetary policy) has a significant negative effect on price except during the fourth quarter where it becomes insignificantly positive for some unknown reason. This evidence rules out the likely presence of the price puzzle[24] in Ethiopia. The tiny response, evidenced here in the panel 3 could reinforce the premise that credit market is at its infancy stage in Ethiopia. Our result is comparable with that of (Baydur & Süslü, 2004) and (Anzuini, Lombardi, & Pagano, 2012), who studied the case of Turkey and the US economy respectively, but very different from that of (Sims C. A., 1992) for OECD countries in that he finds evidence, which suggest the existence of the prize puzzle.

Panel 4. Shows that when there is depreciation in the real exchange rate, general prices rise quickly and stay positive approximately for two quarters. And then, go down and stay insignificantly negative for couple of quarters and start recovering approximately after the fifth quarter then stay positive onwards. In spite of the fact that price insignificantly decrease for two quarters following the impulse to real exchange rate. On average, price increase in Ethiopia following a positive shock to real exchange rate (depreciation). Our result looks appealing in terms of both

[24] The positive relationship between the interest rate (federal funds rate) and inflation has become known as the "price puzzle" (Bernanke and Blinder 1992; Christiano, Eichenbaum, and Evans 1994, forthcoming; and Sims 1992). It is a puzzle because an unexpected tightening of monetary policy i.e. an unexpected increase in interest rate is expected to be followed by a decrease in the price level, rather than an increase.

theoretical and practical context. Depreciation of the real exchanger rate makes an importable commodity to become expensive and this boost the demand for locally produced consumption commodities. Hence, the increased demand put an upward pressure on consumer prices eventually. This situation has been a practical case in countries like Ethiopia that are heavily[25] import dependent economies.

[25] More than 27 Percent of the country's import constitute is of consumer good (Annual report (NBE), 2014).

Table 6.4: Variance Decomposition of D(LY)

Period	S.E.	D(LY)	D(LCPI)	D(LM2)	LRATE	D(LREER)
1	0.089495	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.110171	95.91543	0.319422	1.376494	1.050237	1.338416
3	0.112767	91.82525	2.829624	2.815904	1.228883	1.300335
4	0.121303	79.38301	3.000565	14.94062	1.176843	1.498969
5	0.136200	74.19744	2.878653	20.16921	1.535787	1.218911
6	0.138916	73.11849	3.114512	19.99670	2.565467	1.204827
7	0.140424	72.57659	3.588319	19.83395	2.806176	1.194971
8	0.142518	70.46083	4.281894	21.18182	2.777733	1.297720
9	0.146673	70.47575	4.281536	21.07450	2.892633	1.275579
10	0.147274	70.11804	4.503825	20.98027	3.029095	1.368774
11	0.148084	70.11949	4.560214	20.95528	3.001216	1.363805
12	0.149148	69.17488	4.904608	21.50198	3.029487	1.389049
13	0.150725	69.33827	4.842871	21.35226	3.077483	1.389117
14	0.151051	69.03928	5.022562	21.41327	3.114882	1.410003
15	0.151500	69.12878	5.007377	21.33455	3.110340	1.418960
16	0.152083	68.68953	5.184533	21.59699	3.105898	1.423050
17	0.152673	68.78989	5.146639	21.48632	3.143740	1.433411
18	0.152924	68.60520	5.250381	21.56240	3.145548	1.436471
19	0.153139	68.65553	5.235667	21.50751	3.154864	1.446433
20	0.153469	68.46431	5.319883	21.62636	3.145744	1.443696

Table 6.5: Variance Decomposition of D (LCPI)

Period	S.E.	D(LY)	D(LCPI)	D(LM2)	LRATE	D(LREER)
1	0.048893	1.224603	98.77540	0.000000	0.000000	0.000000
2	0.051979	4.504483	87.44516	0.019764	4.289790	3.740799
3	0.053716	5.336063	81.88816	0.364592	4.424740	7.986443
4	0.055548	5.113617	76.68988	4.159726	6.543065	7.493714
5	0.056656	5.058996	75.00662	5.079730	7.646653	7.208001
6	0.057598	6.770482	72.68777	5.273120	8.032025	7.236605
7	0.057761	6.902586	72.27937	5.243438	8.372727	7.201876
8	0.057830	6.931826	72.13827	5.320092	8.422251	7.187558
9	0.058258	6.944071	71.36104	6.192166	8.407635	7.095093
10	0.058497	7.331965	70.83677	6.180592	8.588667	7.062006
11	0.058576	7.526991	70.66779	6.171266	8.590635	7.043321
12	0.058590	7.554148	70.63398	6.173719	8.591687	7.046465
13	0.058741	7.632852	70.37700	6.411175	8.567728	7.011243
14	0.058823	7.722442	70.21550	6.430784	8.623051	7.008222
15	0.058876	7.843589	70.10081	6.437186	8.622361	6.996051
16	0.058882	7.849356	70.09306	6.437817	8.620731	6.999038
17	0.058945	7.920034	69.97656	6.514853	8.604287	6.984264
18	0.058975	7.931785	69.92868	6.534633	8.621280	6.983618
19	0.059006	8.004814	69.86026	6.538768	8.618991	6.977166
20	0.059011	8.003561	69.85512	6.545349	8.617863	6.978102
Cholesky Ordering: D(LY) D(LCPI) D(LREER) D(LM2) LRATE						

Source: author's computations.

7 Conclusion

In this paper, we employed a structural vector auto regression (SVAR) approach to investigate the effects of monetary policy shocks on output and prices in Ethiopia. We tried to isolate the SVAR structural shocks by imposing restrictions on the long-run behavior of the variables in the model, and these long-run restrictions are derived directly from the underlying economic models and practical situation. This places a recursive restriction on the disturbances of the SVAR and help to generate impulse response functions that track the effects of monetary policy innovations on output and prices.

Generally, we find evidence that monetary policy innovations have both real and nominal effects on economic parameter depending on the policy variable selected. Our results suggest that price-based nominal anchors (Interest rate and Real Effective Exchange Rate) have influence on real economic output. Specifically, our empirical result indicates a modest impact of lending rate but significant influence of real exchange rate on real economic activity. Similarly, innovation in the quantity based nominal anchor M2 (stock of broad money supply) affects economic activities significantly. Therefore we can observe that monetary policy shocks have been a drive of business cycle fluctuations in Ethiopia.

We understand that the implementation and the scientific study of monetary policy in a developing country like Ethiopia faces additional challenges that may not present in developed economies. Therefore, to better understand the impacts of monetary policy shocks on output and prices in the developing countries specifically, we believe it will be instructive for future research in this field to consider include fiscal policy variables and do comparative analysis using different competing empirical methodologies.

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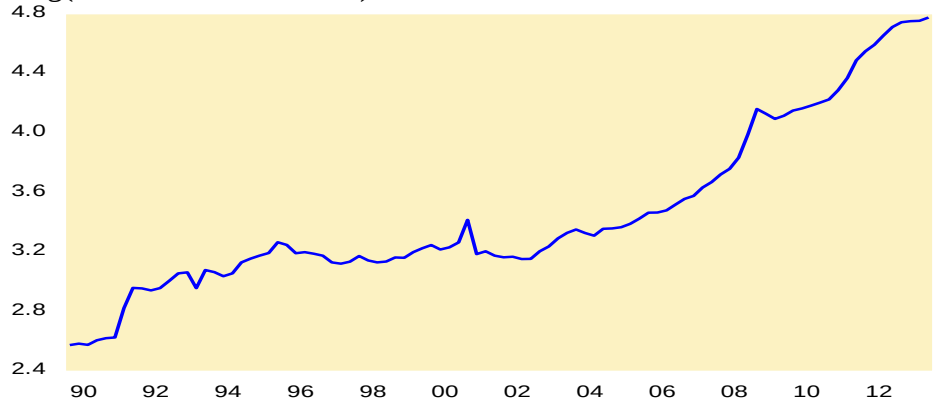
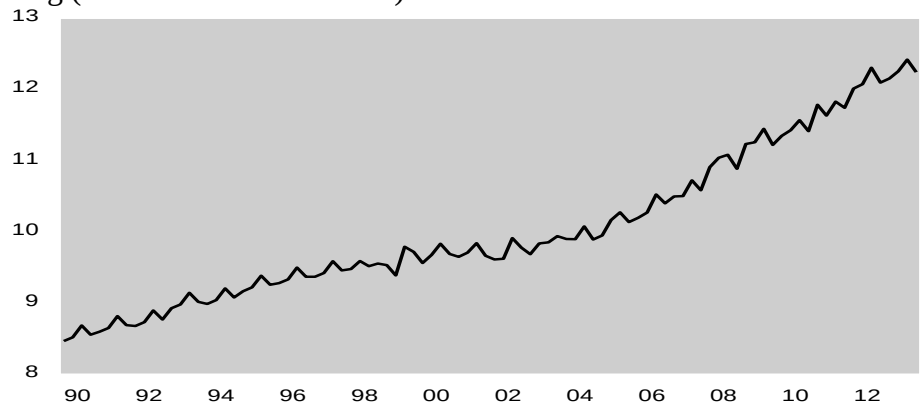
Appendix: Time Series

Figure 0.1: Time Series plots

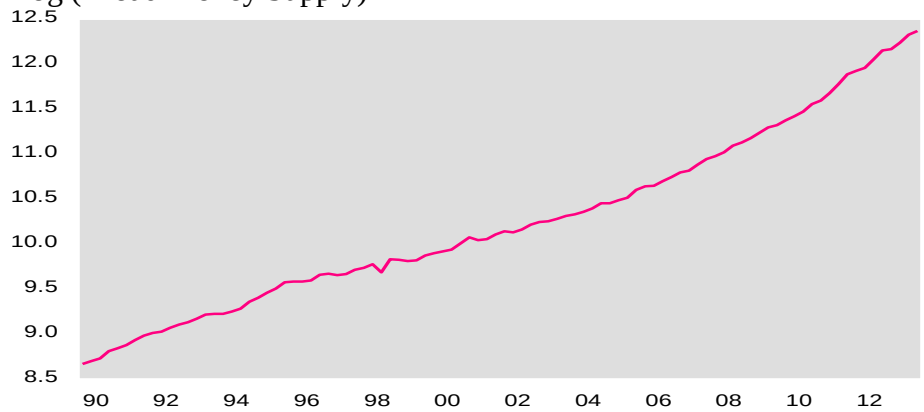
1. Log(Consumer Price Index)



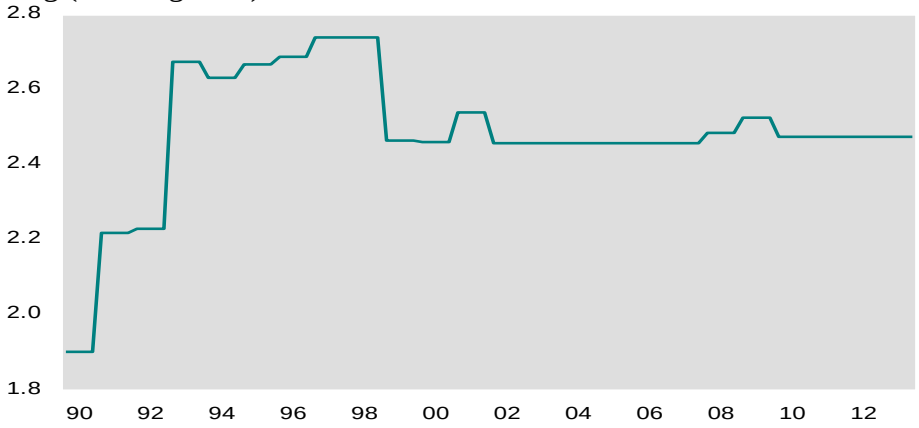
2. Log (Gross Domestic Product)



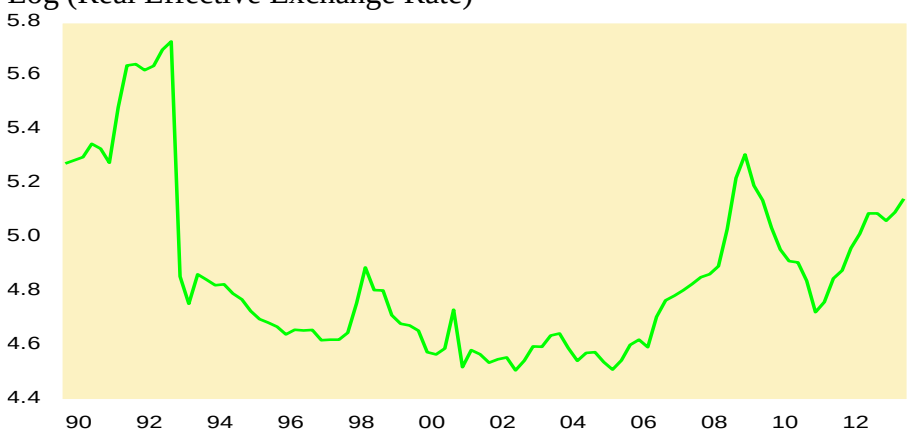
3. Log (Broad Money Supply)



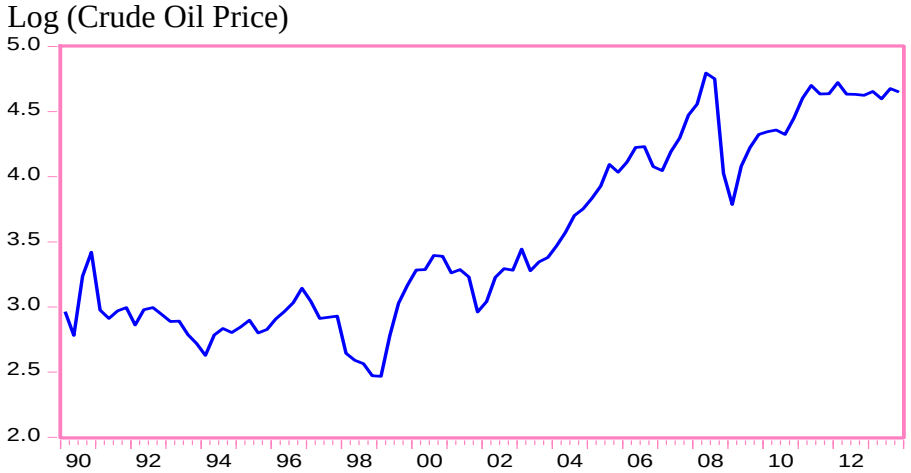
4. Log (Lending Rate)



5. Log (Real Effective Exchange Rate)



6. Log (Crude Oil Price)



Source: author's computations.

Null Hypothesis: a Variable has a unit root

Exogenous: Constant, Linear Trend

Table 0.1: Unit root test result

1. D(LCPI)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.816522	0.0000
Test critical values:	1% level	-4.058619	
	5% level	-3.458326	
	10% level	-3.155161	

2. D(LGDP)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.511462	0.0025
Test critical values:	1% level	-4.063233	
	5% level	-3.460516	
	10% level	-3.156439	

3. D(LM2)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.238584	0.0836
Test critical values:	1% level	-4.062040	
	5% level	-3.459950	
	10% level	-3.156109	

4. D(Lreer)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.574688	0.0000
Test critical values:	1% level	-4.058619	
	5% level	-3.458326	
	10% level	-3.155161	

5. LRATE

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.476558	0.0107
Test critical values:	1% level	-3.500669	
	5% level	-2.892200	
	10% level	-2.583192	

6. LOIL

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.994124	0.0000
Test critical values:	1% level	-4.059734	
	5% level	-3.458856	
	10% level	-3.155470	

Source: author's computations.

Null Hypothesis: A variable has a unit root with a structural break in both intercept and trend

Table 0.2: Zivot-Andrews test for unit root with structural break

1. CPI

Chosen lag length: 1 (maximum lags: 4)
Chosen break point: 2007Q1

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-3.848475	0.880015
1% critical value:	-5.57	
5% critical value:	-5.08	
10% critical value:	-4.82	

2. GDP

Chosen lag length: 4 (maximum lags: 4)
Chosen break point: 2007Q2

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-2.507508	0.688174
1% critical value:	-5.57	
5% critical value:	-5.08	
10% critical value:	-4.82	

3. M2

Chosen lag length: 4 (maximum lags: 4)
Chosen break point: 2008Q3

	t-Statistic	Prob. *
Zivot-Andrews test statistic	0.307988	0.640684
1% critical value:	-5.57	
5% critical value:	-5.08	
10% critical value:	-4.82	

4. REER

Chosen lag length: 0 (maximum lags: 4)
Chosen break point: 1996Q4

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-3.623606	0.891200
1% critical value:	-5.57	
5% critical value:	-5.08	
10% critical value:	-4.82	

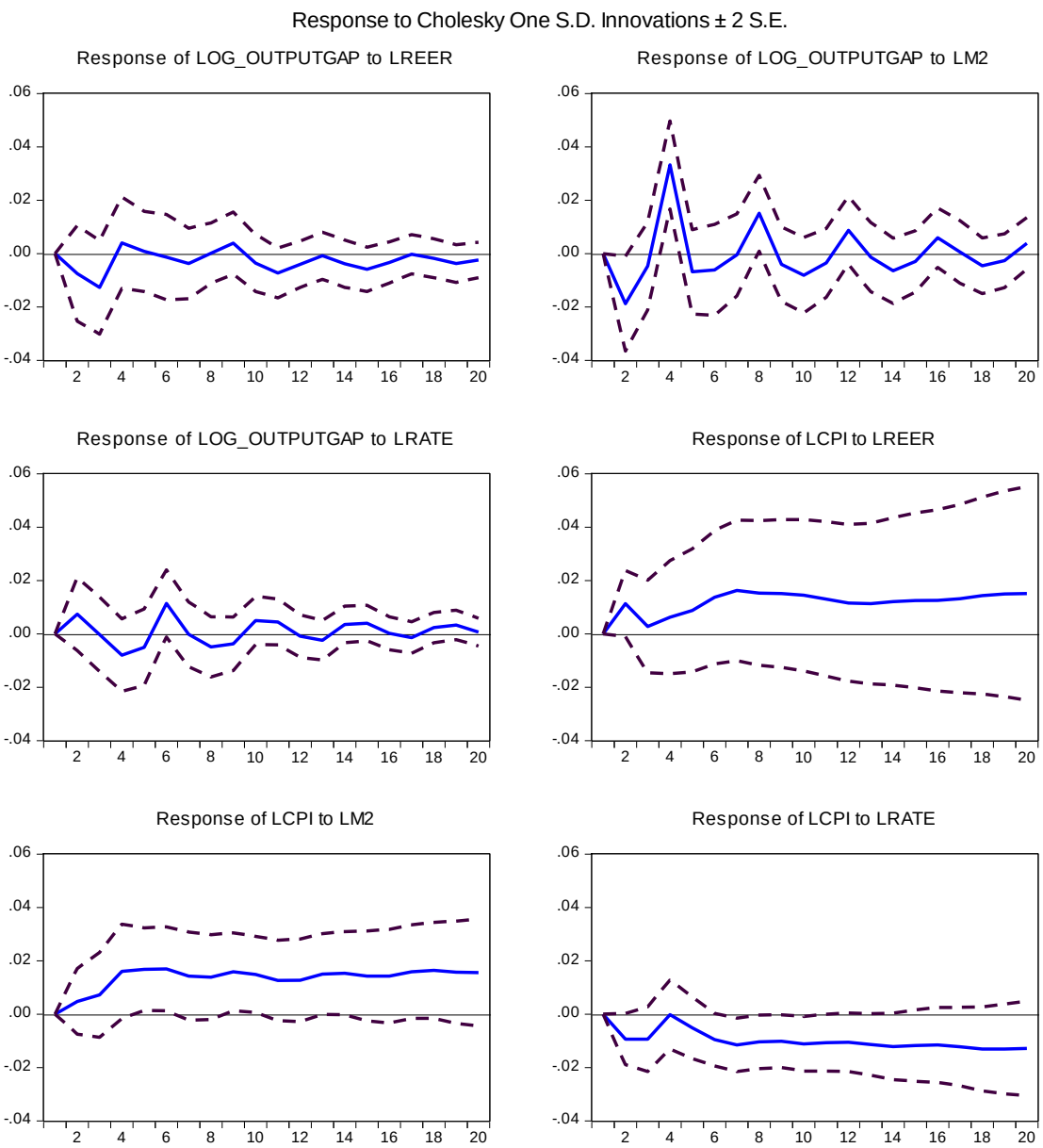
5. LRATE

Chosen lag length: 0 (maximum lags: 4)
Chosen break point: 1999Q1

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-4.195913	2.01E-17
1% critical value:	-5.57	
5% critical value:	-5.08	
10% critical value:	-4.82	

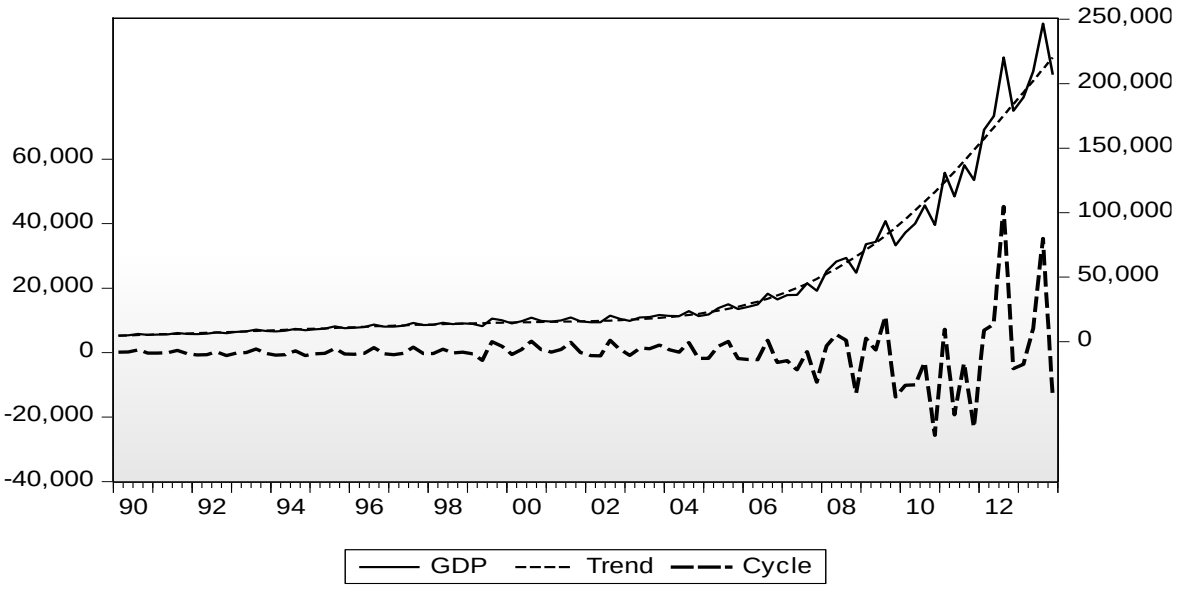
Source: author's computations.

Figure 0.2: Output (measured by output gap) and Price effect of innovation in monetary policy



Source: author's computations.

Figure 0.3: Output gap estimate using H-P Filter (Lambda = 1600)



Note: Quarterly Data. The output gap is the average difference between real output and potential output, measured as a fraction of potential output using seasonally adjusted data. The use of lambda =1600 widely suggested by (Hodrick & Prescott, 1997), when estimating an H-P filter for quarterly data

Source: author's computations.

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